[illegible] QUESTIONS

ON

BIOLOGY

(For Intermediate Students)

BY

AN EXPERIENCED PROFESSOR

Revised by

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BIOLOGY

1935

FIRST PAPER

Q. 1. *Describe a typical vegetable cell.*

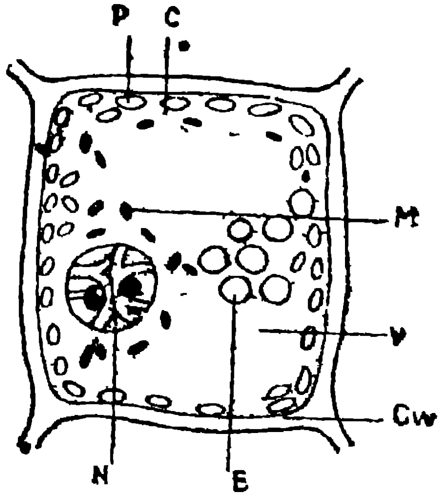
Ans. A cell is a unit mass of living matter usually with protoplasm and a nucleus. Generally the plant or animal body is made by the combination of different types of cells, hence these cells are the structural units of the living body. A cell may be living or dead. A dead cell loses all its living contents and is generally seen to contain air or water. A living vegetable cell contains protoplasm, nucleus and plastids [illegible] essential structures. Every cell does some special types of duties—definite physiological functions, hence the cells are also the functional units of the living body. *A typical vegetable cell* means an ideal young plant cell which has the following parts —

(1) A definite **cell-wall**, made of a kind of carbohydrate called the cellulose This cell-wall forms the skeleton of the plant and is capable of thickening and growth.

(2) A jelly-like, colloidal, transparent life-substance is called the **protoplasm**. It is divided into two parts ectoplasm and endoplasm. The protoplasm occupies nearly the whole space within the cell when young. Vacuoles appear in the cell when it is grown or fully matured.

Plant cell :

Cw —Cell-wall ;
N —Nucleus ,
P.- Plastids ,
C.—Cytoplasm ;
M —Mitochondria ,
E.—Ergastic substances ;
V.—Vacuole.



(3) A highly differentiated protoplasmic body called

nuclear membrane, karyolymph, nu
omatin granules and nucleolus.

Some small granular and highly specialised living bodies are called **plastids**. The plastids are of different types and are distinguished by their definite colours.

* (5) A star-shaped structure called **centrosome** is found in the vicinity of the nucleus of animal cells and some lower plant cells. In higher plants centrosome is totally absent.

(6) Some small granular, rod-like or filamentous bodies known as the **chondriosomes** or **mitochondria** are found universally in the plant or animal cell.

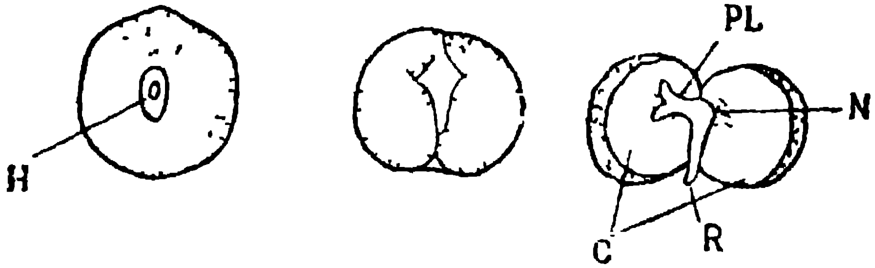
(7) An extensive net-work made of substances known as **Golgi bodies** are found in many plant cells. These are the characteristics of an animal cell

(8) Various secretory, excretory and reserved materials of the non-living nature are found in the cell These are jointly called **ergastic substance** and are really the products of metabolism.

(9) One or many small cavities containing a watery fluid are found within the cell These cavities are called **vacuoles**. A layer of protoplasm called tonoplasm is found surrounding each vacuole.

Q. 2 *Describe the structure of a pea-seed and the mode of its germination*

Ans The pea is a **dicotyledonous** exalbuminous seed, *i. e.*, it has two cotyledons or seed-leaves where the food-matter is stored up. A seed is called exalbuminous when the food-matter is stored up within the cotyledons, not outside.



Structure of a Pea-seed.

H.—Hilum ; PL.—Plumule ; C.—Cotyledons ;
R.—Radicle ; N.—Nodal zone.

Structure :

(a) *External* ;—Its form is round or wrinkled. Its colour varies from green to yellow and white. There is a bulged out portion just under which is a scar called **hilum**, which indicates the position where the seed remained attached to the stalk. Under the hilum a minute pit called **micropyle** is found. The outermost covering of the seed is called the **testa**.

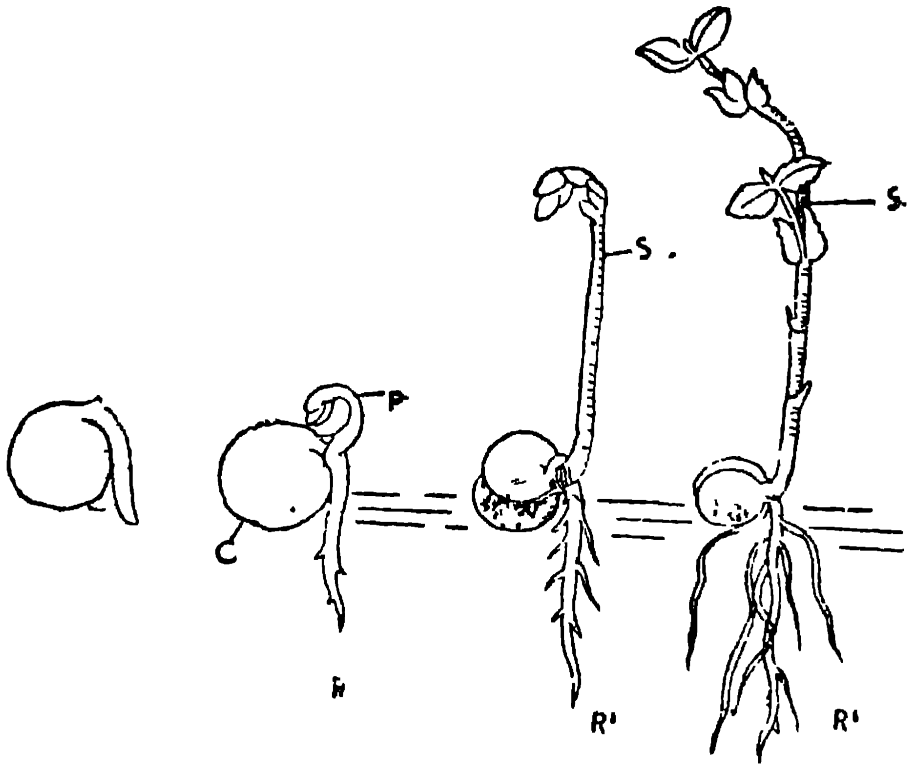
(b) *Internal* ·—In *other* seeds, when the testa is peeled off, another membranous thin coat is seen under the testa. It is called the **tegmen**. In pea-seed, testa and tegmen remain fused together When this fused covering is peeled off, a fleshy mass called **kernel** is exposed. It consists of **embryo** only. The embryo consists of two fleshy lobes called **cotyledons** or seed-leaves and also a small **axis**,—the axis of the embryo or baby plant. It lies in between the two cotyledons and attaches itself to it and consists of two parts :

(1) **Plumule**, or the future shoot which lies at one end and grows up into the air, becomes green and produces leaves and stem afterwards.

(2) **Radicle** or the future root : it lies at the opposite end and grows down into the soil to form the primary root. The point of attachment of the axis to the cotyledons is called the **nodal zone** The portion of the axis between the nodal zone and the plumule is called the **epicotyl** and the portion between the nodal zone and the radicle is the **hypocotyl**. (*Epi*—above, *Hypo*—under or below).

Germination :

When the seed is placed under suitable conditions, it germinates, *i.e.*, awakes from the dormant stage. The seed swells up with water and first through the micropyle the radicle comes out due to its rapid growth and goes down into the soil to form next the plumule comes up by the activi he epicotyl and becomes shoot. The cotyledon buried in the soil and within the testa. Thi type of germination is known as **hypogeal**. Gradually th cotyledons become thinner and at last wither and fall off.



R. = Radicle , P = Plumule ; C. = Cotyledons ,
S. = Shoot , R = Root.

Q. 3. *Draw a diagram of a typical leaf and label its parts. What are the normal functions of the leaf?*

Ans. A typical leaf means a typical foliage leaf. It has the following parts ,—

(1) **Leaf-blade** or **lamina** or **epipodium** is the thin, bright green, expanded portion always traversed by a system of strong network consisting of **veins** or the branches of the axis of the epipodium. The axis is known as **mid-rib.**

The free top end of the lamina is known as the **apex** and the sides are the **margins.** The portion where the lamina is attached to the stalk is the **base**

(2) **Petiole** or **leaf-stalk** or **mesopo**[illegible]re separated stalk like more or less cylindrical portion of the [illegible] walls. porting the lamina.

(3) **Leaf-base** or **hypopodium** is the portion by which the petiole remains attached to the stem.

A = the leaf lamina or leaf blade or epipodium ;

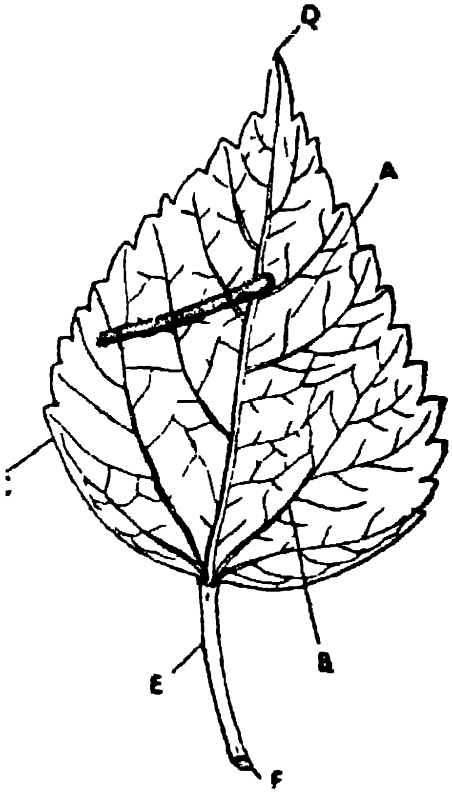
B. = Leaf veins ;

C = The leaf margin ;

D. = Leaf apex ;

E = Leaf stalk or petiole or mesopodium ;

F. = Leaf-base or hypopodium.



The epipodium, mesopodium, and hypopodium are together known as the **phyllopodium**. When any of these parts is absent the leaf is called incomplete.

Normal functions

(1) It is the organ of assimilation. This is generally done by the help of green colouring matter called chlorophyll.

(2) It absorbs carbon dioxide and gives out oxygen during assimilation and *vice versa* during respiration. Hence it is also an organ of respiration.

(3) It is a suitable organ for transpiration or expulsion of the excess quantity of the water absorbed by the root.

(4) It also serves as an organ for excretion.

(5) It serves the function of protection of the axillary buds.

understand by Photosynthesis? Describe
by which you demonstrate it.

Photosynthesis (*Photos*—light, *synthesis*—building up) is the term strictly meaning the building up of complex organic carbon compounds (starch, sugar, etc.) from simpler inorganic ones (CO_2 and H_2O) by the green colouring matter called chlorophyll in the presence and with the help of sunlight. This process is also known as **carbon assimilation**.

The green parts of the plants (usually the green foliage leaves) absorb CO_2 from air, and the root absorbs water from the soil The chlorophyll, present, in the plastids with the help of sunrays, transforms the elements present in the carbon dioxide and water in such a fashion that a complex organic substance (sugar) is produced and oxygen is set free

[During photosynthesis carbon dioxide enters into the intercelluar spaces through the stomata (or minute openings on the undersurface) of the leaf and from the intercellular spaces by diffusion into the cavity of the cells where the chloroplastids are arranged on the wall. The carbon dioxide (as previously mentioned) changes into carbon compounds and the surplus oxygen is given out by the plants through the stomata The following reactions take place —

$$CO_2 + H_2O = CH_2O \text{ (Formaldehyde)} + O_2.$$

$$6(CH_2O) = C_6H_{12}O_6 \text{ (grape-sugar)}$$

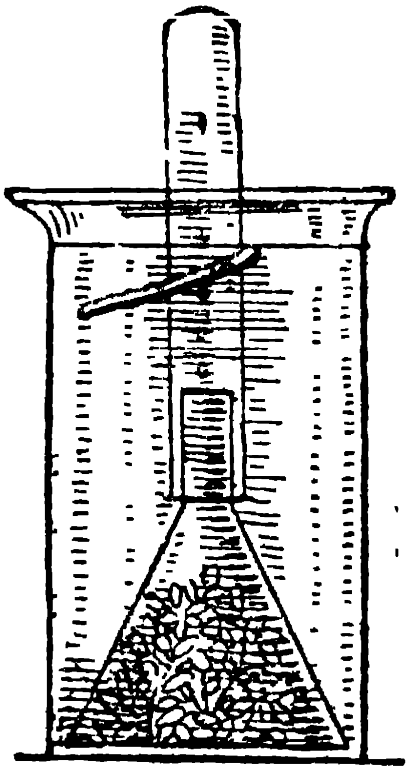
Each molecule of sugar afterwards loses one molecule of water—a number of such molecules condenses together to form what is known as starch

$$[n(C_6H_{12}O_6) - n(H_2O)] = (C_6H_{10}O_5)n.$$

This kind of starch is known as *assimilatory starch* and is stored up in the mesophyll cells during the daytime The conversion of the sugar into starch prevents the over-saturation of the cell-sap with sugar which stops further photosynthesis. Thus the storage of starch helps the photosynthesis to go on continuously during day time At night due to the absence of light photosynthesis stops and the starch, by the action of a ferment, diastase, is reconverted into grape-sugar and is translocated to the various portions of the plant body.

Experiment ;

Take some small waterplant in a beaker half-filled [illegible] water in which CO_2 is dissolved. Cover the plants with an inverted funnel in such a manner that its stem remains immersed into the water. Take a test tube filled with (cold) water and invert it on the stem of the funnel under water. Now expose the whole thing to direct sunlight After a few minutes small bubbles of gas will begin to evolve Alkaline pyrogallate absorbs this gas, hence it is oxygen Now cover the whole apparatus except the test-tube with black paper in order to cut off the sunrays, the evolution of bubbles will gradually slow down and ultimately stop. This proves that photosynthesis cannot take place in absence of light. Now replace the water of the beaker with water previously boiled to drive out its dissolved gas and perform the same experiment in sun light No bubble will evolve showing that carbon dioxide is necessary for photosynthesis



Evolution of oxygen

Q 5 *What do you understand by 'alternation of generations' in the life-history of a plant ? Illustrate your answer by reference to the Moss plant or to the Fern plant*

Ans. Two distinct stages, one sexual and another a-sexual, alternate with one another in the life-history of nearly all the higher plants. This phenomenon of alternation between sexual and asexual stages is known as *'alternation of generations'*.

In one of the forms, known as the **gametophyte**, a-sexual process occurs , the other, known as the **sporophyte** (is the plant itself) producing spores which later on may pass into gametophytic stage. The **gametes** or germ cells, produced by the gametophyte, on the other hand, come in pairs and conjugate, and produce **zygote** – a structure which develops not into another gametophyte but into a sporophyte. Similarly, the

the sporophyte develop into gametophytes [illegible]rophytes.

nation of generations as observed in Fern :

The plant is the sporophyte. It bears spores, within sac-like bodies called **sporangia** The spores are of the same size and form and are liberated by the rupture of the sporangia. If one of them falls to the suitable place in moist and shady situation, it germinates to produce a structure known as the **prothallus** It is an independent, self-supporting plant consisting usually of green heart-shaped plate not more than a quarter of an inch in diameter It remains attached to the soil by means of delicate, hairy, root-like structures called **rhizoids** developing from its under surface The sexual organs male, **antheridia** and female, **archigonia** also develop on the lower surface of the same prothallus. The prothallus, therefore, is hermaphrodite

In each archigonium a female gamete or **oosphere** is developed Each antheridium contains many male gametes or **antherozoids** or **spermatozoids** When the gametes are matured, the antherozoids are attracted by the archigonia by secreting malic acid loved by the antherozoids. Next each antherozoid thus attracted fertilises the oosphere of the attracting archigonium and produces an **oospore** From each oospore the sporophytic generation develops

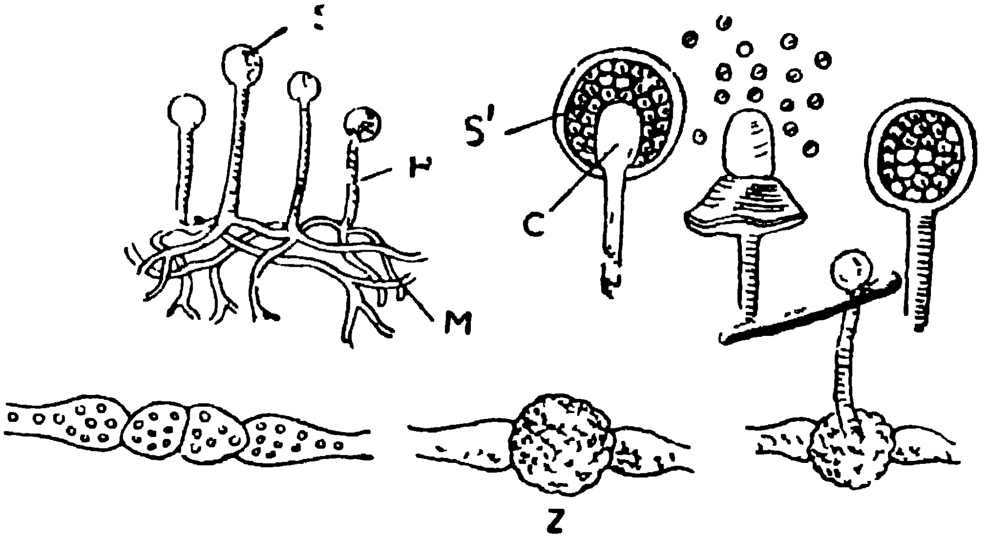
N. B—In Moss reverse condition is found Plant is the gametophytic stage there and the sporogonium containing spores is the sporophytic stage

Q. 6. *Describe briefly the life-history of Mucor.*

Ans. The familiar name of mucor is 'mould' and it is found as a saprophyte on the medium, rich in starch and sugar. It forms a white cotton-like growth on bread, preserved fruits, cheese, etc.

Vegetative body :

The body of the fungus is made of filamentous much-branched thallus known as the **mycellium** The filaments of which the mycellium is made up, are known as **hyphæ**. They are full of granular and vacuolated cytoplasm,oil drops and glycogen. Some of the hyphæ penetrate the medium on which the plant grows and serves as anchors for the superficial mycellium. They also draw nourishme[redacted]e whole plant[redacted]re separated is no partition wall, [redacted]us it is a unicellular fu[redacted]walls. nuclei Such a structure having one cell and m[redacted] is called a **coenocyte**. In this connection it is also to be remembered that this non-septate condition is the characteristic



S Sporangium , C. = Collumella , Ś. = Spores ;
M = Mycellium ; H = Hypha.

of a young and vigorously growing mycellium. In older hyphæ cross walls are frequently found and the reproductive parts are occasionally distinguished from the vegetative one by septa.

Reproduction :

A-sexual.—Under favourable conditions the plant reproduces a-sexually by forming **spores** During the process some aerial hyphæ elongate and their tips begin to enlarge and become swollen and are cut off from the rest by means of partition-walls forming what are known as the **sporangia** The hyphæ bearing sporangia are called **sporangiophores** Into each sporangium a considerable amount of cytoplasm with many nuclei along with a certain amount of reserve food flow from the adjoining parts. The central portion is poor in food and number of nuclei and is cut off from the sporangium by a protoplasmic membrane. This region is sterile and is known as **collumella** The protoplasmic contents of the sporangium divide into a number of cells each containing 2-10 nuclei. These cells secrete walls round them and are thin-walled and oval in shape, called spores. When

the sporangium wall disorganises liberating
hen fall to the suitable substratum, germinate
ice new mycellium.

Sexual:—When unfavourable condition comes, specially food shortage takes place, the a-sexual reproduction stops and the plant reproduces sexually by conjugation During this process two hyphæ of different sexes known as *plus and minus strains* (the difference is only physiological) approach and meet together. Now a transverse partition-wall is formed at a short distance away from each tip in each hypha Thus two **gametangia** are formed and their protoplasmic contents are called **gamates.** These come closer still and finally fuse together , the intermediate wall between them having disappeared and the **zygospore** thus formed secretes a thick wall The special hyphæ bearing a gametangium is called **suspensor** The zygospore is a resting spore It germinates when favourable conditions return again and produce **promycellium** which bears sporangium From each sporangium spores are produced and each spore produces a new mycellium

Parthenogenesis ·—When conjugation fails, each gamate produces zygospore-like bodies called **azygospore** which germinates to form promycellium

Torula condition of mucor

When a piece of mucor is placed in sugar solution, it divides into thin-walled cells known as **oidia** by transverse partition-walls Thus cells go on budding like the yeast and produce alcoholic fermentation in the sugar solution

Q 7 *Some yeast cells are put into a solution of sugar and kept in a warm place. Describe the changes that may take place in (a) the yeast, and (b) the solution.*

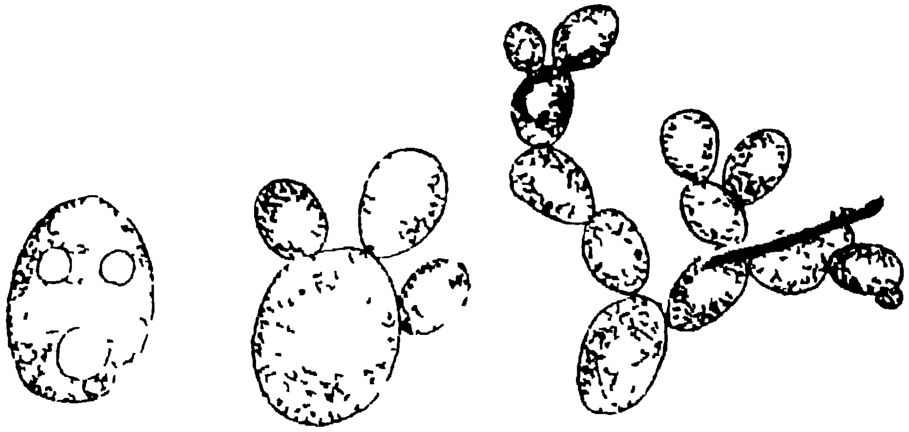
Ans. Changes in yeast plant :

The changes that take place in the yeast depend upon the quantity of the sugar solution.

(*i*) When the sugar solution is abundant, the yeast plants multiply by **budding** During the process the nucleus divides directly into two parts and from the mother cell an outgrowth appears. Gradually the daughter nuclei pass into these outgrowths. These outgrowths may repeat the process and chains of cells may be for[illegible]owly these outg[illegible]re separated from the mother[illegible]by the formation of partiti[illegible]walls.

(*ii*) When the sugar solution becomes scanty, [illegible]e plants multiply by a-sexual process.

During this process each yeast cell becomes swollen up and its nucleus divides generally into eight daughter nuclei. All the daughter nuclei together surrounding the cell contents, are transformed into a body known as **ascospore** The mother cell is called **ascus** The ascospores are liberated by the rupture of the ascus-wall and under suitable conditions reproduce by budding



Yeast.

Change in the sugar solution :

When yeast cells grow in sugar solution, alcoholic fermentation begins in it Sugar is broken down by an enzyme called **zymase** which is produced from the yeast cells By this process alcohol is produced and carbon dioxide is given off in streams of bubbles forming froth over the surface of the solution. The rate of alcoholic fermentation varies inversely to the supply of oxygen

The chemical reaction can be represented as follows ;—

$C_{12}H_{22}O_{11} + H_2O = 2C_6H_{12}O_6$
(cane sugar) (water) (simpler sugar)
$C_6H_{12}O_6 = 2C_2H_6O + 2CO_2$
(alcohol) (carbon dioxide).

Describe the main differences between plants and

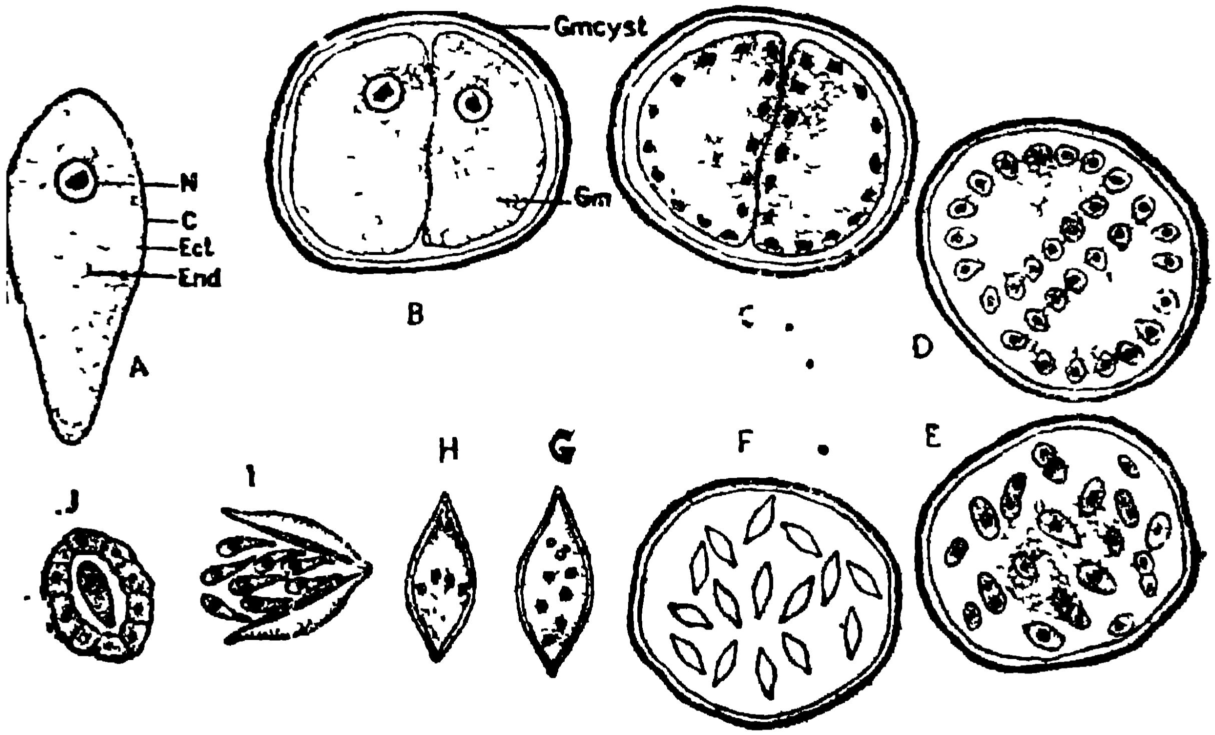
Ans :—

PLANTS	ANIMALS
Morphologically :	*Morphologically .*
(1) Plants are usually branched and a-symmetrical.	(1) Animals are unbranched and symmetrical.
(2) Plants are usually green due to the presence of a green colouring matter known as chlorophyll.	(2) Animals contain no chlorophyll, hence they are usually non-green.
(3) Plants are usually stationary. Only a few lower plants have the power of locomotion.	(3) Animals have usually the power of locomotion and are not fixed Only a few animals are fixed throughout the greater part of their life.
Histologically :	*Histologically :*
(1) Plant cells have non-living cell-wall made of a substance called cellulose.	(1) Animal cells have no cell-wall and contain no cellulose. The limiting membrance is protoplasmic hence living.
(2) Plant cells possess plastids.	(2) Animal cells possess no plastids.
(3) Plant cells usually possess no centrosomes. Only a few lower plants possess centrosomes.	(3) Animal cells usually possess centrosomes.
(4) Plant cells store up various kinds of carbohydrates.	(4) Animal cells contain only glycogen as stored carbohydrates.
Physiologically :	*Physiologically ·*
(1) Plants cannot take solid food. It must be liquid or gaseous.	(1) Animals can take up solid, liquid and gas.

PLANTS	
[illegible]siologically (contd.	*Physiologically (contd.)*
(2) Plants usually prepare their own food from the simple inorganic substances and convert them into complex organic substances, usually.	(2) Animals cannot prepare their own food from simple inorganic substances, therefore they are to depend on plants or animals for their food supply directly or indirectly.
(3) Plants have no definite excretory organs.	(3) Animals usually have definite excretory organs.
(4) Plants grow and develop usually throughout life.	(4) In animals growth and development cease [illegible] before death.

Q. 2 *Give an account of the life-history of Monocystis*

Ans. Monocystis may be obtained as parasite in the vesiculæ seminalis of the earthworm. It is a sporozoa and therefore



Life-history of Monocystis

A—Trophozoite ; N.—Nucleus ; C.—Cuticle · Ect —Ectoderm ; nd.—Endoderm ; BCDE.—Formation of Gametes , Gmcyst—Gametocyst ; Gm.—Gametocyte ; F. H.—Spores ; I.—Sporozoites ; J.—Young trophozoite.

has a complic[redacted]history. [redacted]has got the following stages in its life-hi[redacted]

[redacted]ophozoite :

It is the adult parasite which has single elongated cell surrounded by a thin **cuticle**. Below this cuticle a clear and hyaline **ectoplasmic layer** is found. The greater part of the cytoplasm consists of tne **endoplasm**—a granular layer lying next to ectoplasm. A number of nutrient bodies are seen which appear granular. Some fibrils known as **myonemes** are found in the ectoplasm which contract from time to time and thus impart movement to the animal. The **nucleus** is large and embedded in the endoplasm The presence of cuticle prevents the disc[redacted]ge of pseudopodia. Contractile vacuole and food vacuoles are [redacted]t.

(*b*) **Gametocytes :**

At the time of reproduction, these trophozoites seek one another. Two individuals come side by side and surround themselves with a thin double-walled case called **cyst** The individuals which are now called the **gametocytes** cannot be definitely distinguished as to which is male or female The nucleus of each parasite divides by mitosis until a large number of nuclei are formed. Next each daughter nucleus is surrounded by a small mass of cytoplasm and detaches from the parent body. Each one thus formed is called *gamete* Next the gametes unite in couples, and it is a fact that those formed by one gametocyte seek and unite with those formed by the other. Each pair of gametes fuse completely so that the nucleus of one unites with the nucleus of the other.

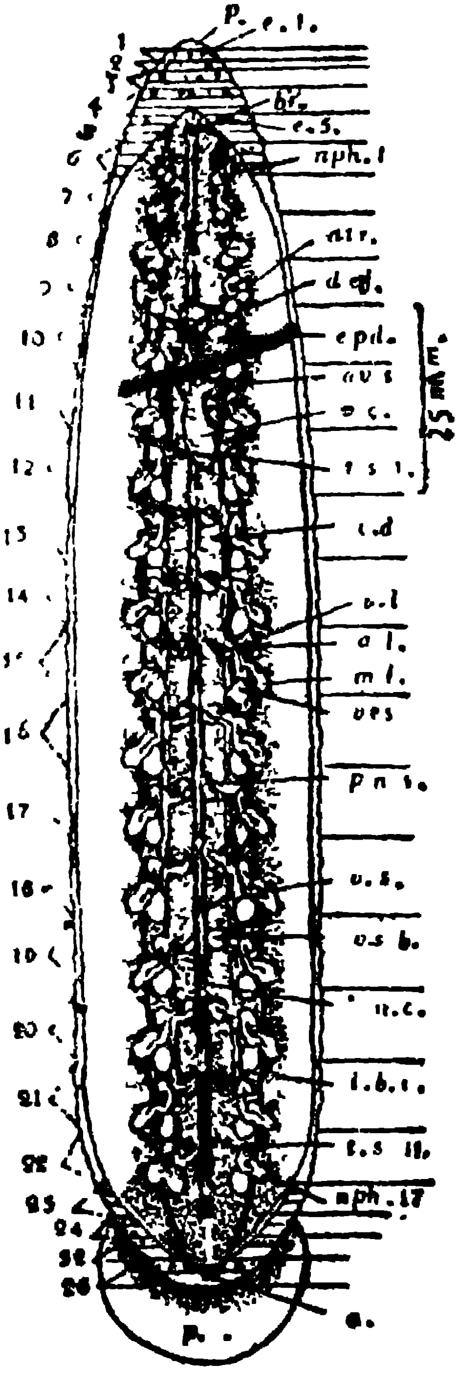
As a result of the union many single cells with large nuclei are formed. Each of these is called a **zygote**. Each zygote secretes a lemon-shaped chitinous spore case called **pseudonavicella** round it and is called the **spore** Next the content of each spore becomes divided into eight small sickle-shaped bodies called **sporozoites**.

(c) **Sporozoites :**

The spore containing sporozoites are the last stage of development that undergoes within the body of the same earthworm. Further development is only possible when these are taken by other earthworm along with the soil. The spore case dissolves in the aliment the earthwo from each sp[redacted]ped bodies called the s erated in the alimentary canal. They penetrate t wall of the alimentary canal and gradually reach the vesiculæ seminalis where they feed on sperms and grow into trophozoites. Thus the life cycle continues

Q 3 *Draw a diagram of the reproductive system of leech and label the various parts*

Ans Leech is hermaphrodite, i. e, male and female reproductive organs are found in the same individual.



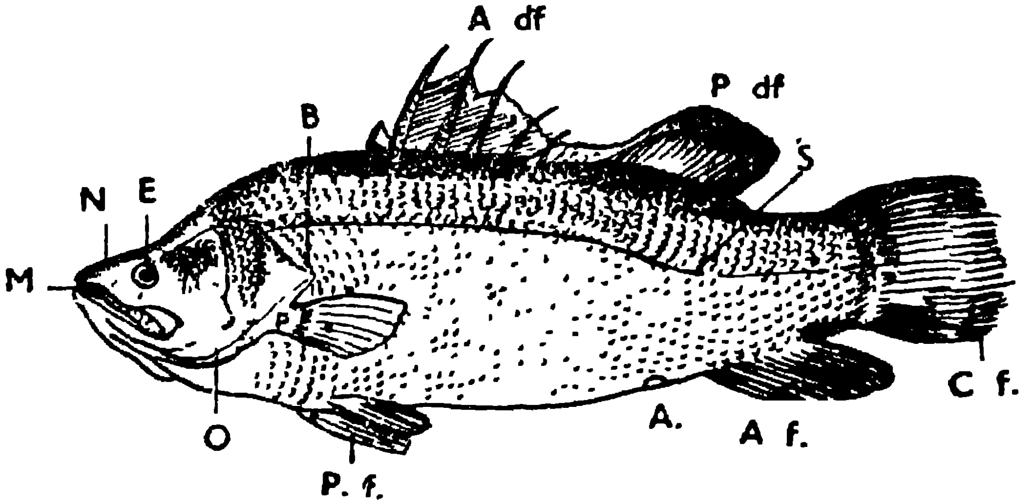
Male

The testes are diffused, glandular bodies lying within **testis-sacs** which are on each side parallel to ventral nerve cord and extends from the twelfth segment of the body to the twenty second segment. Thus there are eleven pairs of testes. Testes of each side are connected to the common sperm duct called the **vasa differentia** of that side by small connecting ducts. These ducts are called **vasa efferentia**. The vasa differentia is tubular and wavy and leads towards the head forming a coil approaching the penis The coiled portion of the duct is called **epididymis** or **vesicula seminalis** which leads into a duct known as **ductus ejaculatorius** or ejaculatory duct. The ducts of both sides lead into a median organ, the **atrium** which consists of a large anteriorly placed base, the **prostate glands**, and a narrow backwardly directed neck the **penis-sac.** The penis-sac is an elongated muscular chamber containing a filamentou[illegible] tube, the **penis** w[illegible] ev[illegible] protruded out through the male [illegible] ope[illegible]ted on the tenth segment of the body

Female :

The female organs are most short and extending to a lesser area. Two tubular coiled bodies called **ovaries** are enclosed within spherical sacs one on each side on the eleventh segment of the body. From the base of each **ovi-sac** arises a short slender **oviduct**. The two ducts unite into a common oviduct and their place of union lies embedded in a thick layer of **albumen glands**. The posterior part of the common oviduct is 'S'-shaped and open[illegible]hind into the **vagina**. The vagina is a large muscular bag lyi[illegible]n the posterior part of the eleventh segment and opens to the exterior through a narrow duct leading to the female generative organ.

Q. 4. *Draw the external features of Bhetki and label the various fins and apertures.*



Ans. M = Mouth with the big gap. N. = Nostrils, two pairs, anterior pairs are guarded by valves and the posterior pairs are free. E = Eye, without eyelid but provided with nictitating membrane. O. = Operculum B. = Branchiostegal membrane. P f. = Pelvic fin (paired) P = Pectoral fin (paired). A. f = Anal fin (unpaired). C. f. = Caudal fin (unpaired) A df = Anterior dorsal fin (unpaired). P. df. = Posterior dorsal fin (unpaired). A = Anal depression, within which the opening of the alimentary canal, reproductive and excretory ducts are found. S. = Lateral line sense organ. The body is covered with cycloid scales.

than the weaker du[redacted]*al system of Toad.* [redacted]

[redacted]ns . The arteries are the thick-walled vessels [redacted] which blood flows from heart to the body with the except of pulmonary arteries. They carry pure and oxygenated blood. From the anterior portion of the ventricle a flask-shaped structure with a long neck arises The bulbous portion is called **conus** and the long neck—the **truncus arteriosus**. This during its course divides into right and left truncus arteriosus These give rise to three arterial arches on each side. These arches are :—

(*a*) Carotid arch—supplies blood to the head region.

(*b*) Aortic or systemic arch—supplies blood to [redacted] body and appendages.

(*c*) Pulmo-cutaneous arch—supplies blood to the skin and lungs

Carotid arch :

From each carotid arch arises—

(1) **External carotid artery**, supplies blood to the tongue and throat

(2) **Internal carotid artery**, supplying the internal parts of the head Each carotid arch shortly after its origin shows a swelling called **carotid labyrinth** or gland This gland has a spongy structure and is supposed to regulate the flow of blood.

Systemic arch :

Each systemic arch from each side of the animal curves backwards and after encircling the œsophagus unites behind the heart with its fellow of the opposite side to form a single trunk This is called the **dorsal aorta** The branches are as follows --

From the arch itself—

(1) **Laryngeal artery**, supplying blood to the larynx

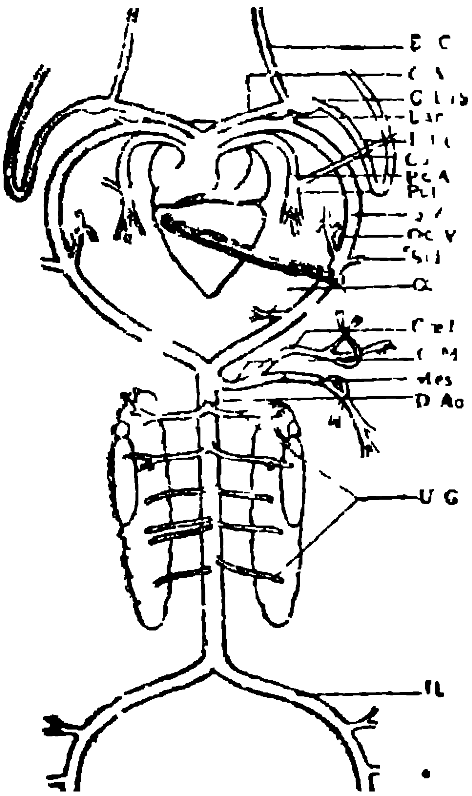
(2) **Occipito, vertebral artery**, supplying blood to the occipital region of the skull and the vertebral column.

(3) **Sub clavian artery**, supplying the blood to the fore limbs.

(4) **Oesophageal artery**, this artery is present only on the left side and supplies blood to the œsophagus.

From aorta—

Coeliaco mesenteric artery is made partially of the left systemic arch and partially of dorsal aorta It further divides into secondary branches **coeliac** and **mesenteric** and supplies blood to the following parts ·—



(*a*) Coeliac branch supplies—

(*i*) Stomach, (*ii*) pancreas, (*iii*) duodenum, (*iv*) liver.

Ex C —External carotid, C A —Carotid arch, C Lab.- Carotid gland. L. ar —Laryngeal artery, Inc —Internal carotid; Cut.—Cutaneous artery; Pc. A —Pulmocutaneous arch, Pul —Pulmonary artery, S A.—Systemic arch', Oc. V.--Occipeto-vertebral artery, Sc —Subclavain artery, Oe —Oesophageal artery, Cœl—Cœliac artery, C. M,—Cœliace-mesenteric artery, Mes —Mesenteric artery, D.Ao —Dorsal aorta, U G.—Urinogenital artery (renal and genital), Il —Iliac artery.

(*b*) Mesenteric branch supplies—

(*i*) spleen, (*ii*) ileum

(2) **Renal arteries** are 4 to 6 in number supplying the kidneys.

(3) **Genital artery** supplies the gonads.

(4) **Posterior mesenteric artery** supplies the rectum.

(5) **Iliac arteries**—the dorsal aorta afterwards splits up into two branches called the iliac arteries which pass to the hind limbs and each bifurcates into two called—

(*i*) **Femoral artery**—supplying the upper part of the thigh and (*ii*) **Sciatic artery**—supplying the back of the leg. Each iliac artery gives a branch to the urinary bladder known as **epigastrico-vesicalis** artery.

than the weaker di

Each pulmo-cutaneous arch gives off two sets of br One set goes to supply the skin and is called the **cutaneous artery**. The other set goes to supply the lungs and is called the pulmonary branch.

Q 6. *Describe the pelvic girdle of Guinea-pig.*

Ans. There are mainly two large similar bony halves that go to form the pelvic girdle. Each of them is called : **Os innominatum** Each of the innominate is composed of three pieces of bones—(1) **Ilium**—a long and projected dorso-laterally placed bone at the anterior region. (2) **Ischium**—a short and dorso-laterally placed bone at the posterior region. (3) **Pubis** – a short and ventrally placed bone at the posterior region.

S = Sacrum ,

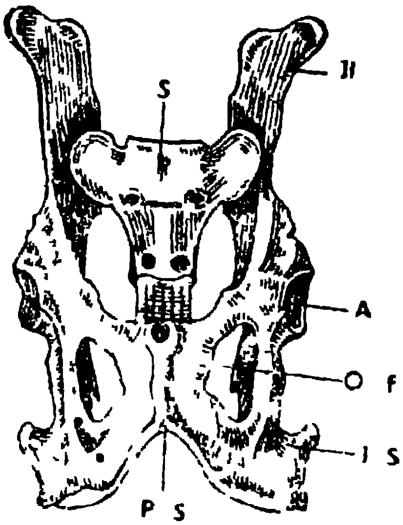
Il. = Ilium

A = Acetabulum ;

O f = Obturator foramen

Is = Ischium ,

P. s = Pubic symphysis.



Both the iliums articulate dorsally and anteriorly with the **sacrum**. Posteriorly and ventrally each pubis meets with its fellow of the opposite side and forms the **pubic symphysis**. This union is brought about by a cartilaginous disc placed between the two. The three bones of each half meet each other and produce at their junction a cup-shaped fossa or cavity called **acetabulum** To this is articulated the head of the thigh bone At the ventral region a foramen is found between pubis and ischium called **obturator foramen**.

Q. 7. *State briefly Darwin's contribution towards the idea of organic evolution.*

Ans. Charles Darwin, the famous scientist and evolutionist, published a very convincing and consistent explanation of organic ev[illegible] This is known by [illegible] tio[illegible] collaborator was **Alfred Russ[illegible] Wallace** [illegible] both [illegible] were believers in the theory of *struggle for existence* already put forth by **Dr Malthus.** Darwin-Wallace's theory was first published in 1858. The theory is based on these facts :

(*i*) **Struggle for existence ;**

(*ii*) **Survival of the fittest ;** and

(*iii*) **Variation,** *i e.*, deviation from the average by modifications and other factors.

Struggle for existence :

Darwin saw, as everyone of us sees, that all organisms multiply at a very high rate , they are very prolific as a rule This *prodigality of production* was already noted by Malthus in 1798 The theoretical calculation shows that the number produced by any organism in a few generations becomes so large that the descendants, if all of them live, can hardly allow any room for anybody else to stay on this earth But this actual theoretical calculation never becomes true in practice, when we see the number of individuals of each species round us. It means that a large number of individuals die very early for some reasons or other and the actual number rarely increases beyond a limit It is a fact that our earth has limited space, food, light and such other means of subsistence

When the means of subsistence are thus limited, and the number of individuals to make use of the same is large as seen in the theoretical calculation, there is bound to be a keen competition for the means of subsistence A keen **struggle for existence** ensues In this struggle, only those who are successful over the others survive Thus in the struggle for existence the fittest only survive , in other words, the **survival of the fittest** is the natural consequence in the struggle for existence

Survival of the fittest :

Who are the fittest ? It is a fact that nature loves the mighty individual and hates the weak During a wrestle between two units one becomes the conqueror and other conquered The most important thing here to note is that a strong individual is not always supposed to be fit A fittest person is he who has **adaptability.** Sometimes a stronger of the two perishes earlier han the weaker du[redacted]ss adaptable [redacted] A tiger is [redacted]an but a man has adapta[redacted]he can use arms and being well guarded by that he freque[redacted] over the tiger.

Variation :

The individuals comprised in a species differ from one another, *i e* , they deviate from the hypothetical form. This type of differences are called **Variations** Some individuals of the same species might be more befitting than the others by acquiring some sort of variations. And in the struggle for existence those befitting individuals due to their variations win and the less adapted individuals are defeated [redacted] tend to stop and obliterate

In discussing Darwin's contributions towards the idea of organic evolution a few points are to be remembered ,

(1) His theory explains the survival of the fittest but not the arrival of the fittest.

(2) His theory of the survival of the fittest is often regarded as the *survival of the luckiest* As applied to man it is found that many unfit are protected, and many merited ones are handicapped the survival cannot, therefore, be of the *fittest* in the sense of the word as originally meant.

(3) Darwin relied on small variations, which are, no doubt, present. But these are dependent on environmental conditions and their inheritance as held by Darwin are now disproved.

(4) Darwin was believer in the *Inheritance of acquired characters* this inheritance is strongly doubted at present.

(5) Darwin, though recognised large variations or *mutations*, but since they were not so common as the small ones, he did not attach any importance to them But it is now regarded by many that they are really important Thus the theory of Natural Selection, though it has not fully solved the problem of the causes of evolution, has its importance in the stimulus it gave to a renewed study of Variations and Heredity. It opened a new field for investigation.

1936

FIRST PAPER

Q. 1. *What is protoplasm? Give some account of the physical and chemical nature of it.*

Ans. The word protoplasm is commonly a general designation for the various substances of which both nucleus and cell-body consist and which together constitute 'living matter while the cell-body or extra-nuclear protoplasm is distinguished as cytoplasm . In a relative unmodified embryonic cell, however, the cytoplasm is a clear semifluid, colourless substance resembling egg-albumin, and it is to this substance that the word protoplasm in its stricter sense is applied " (*Doncaster*)

Protoplasm performs all the vital activities of the living being. Thus it is popularly called the physical basis of of life. Protoplasm can only be seen in its perfect aspect as long as a cell is living After the death of a cell the protoplasm also dies and a perfect feature can never be observed

Physical nature

Although the protoplasm of an unmodified cell may appear homogeneous, it is undoubtedly a jelly-like, viscid, colloidal transparent mixture of carbohydrates, fats and proteins This active substance is contained in isolated chambers called cells and like all other fluids it has no definite shape It has also no definite structure The part of protoplasm which is near about the cell-wall is clear, and thinner than the inner portion which appears granular. The peripheral portion is called 'Ectoplasm' and the inner portion 'Endoplasm' The protoplasm is a highly irritable substance. Hence it readily responds to the stimulus like light, heat, gravity, moisture, etc. It coagulates rapidly by the action of heat or alcohol and dissolves in the solution of potash, chloral hydrate, etc. It has the power of movement.

Chemical nature :

It is of course, impossible to analyse living protoplasm. When, however, dead protoplasm is analysed, it is seen very complex and varied in chemical composition It chiefly contains proteins, fats, carbohydrates and other organic substances.

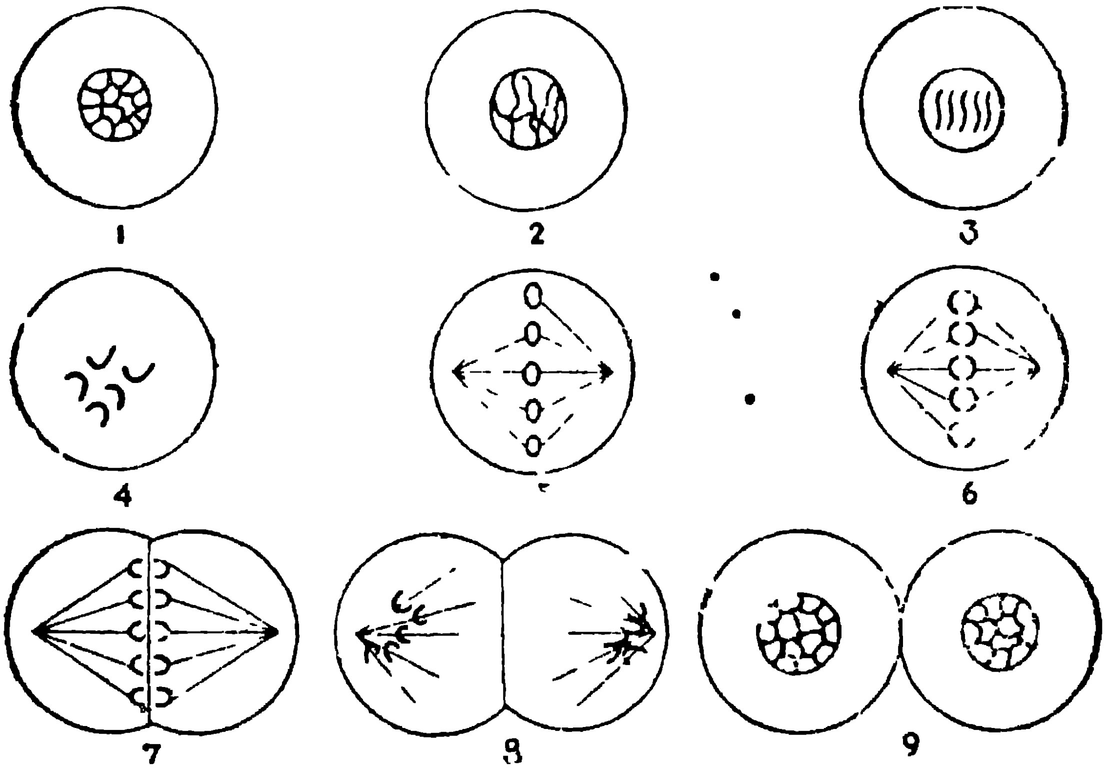
Protoplasm conta[redacted]owing elemen[redacted]rding to the [redacted]h :—

Carbon	50 to 55%
Hydrogen	6 5 to 7·3%
Nitrogen	15 to 17·6%
Oxygen	19 to 24%
Sulphur.........	·3 to 2·4%

and traces of Potassium, Sodium, Magnesium, Iron and Chlorine Besides these, nucleus contains an additional amount of Phosphorus

Q 2 *Give a short account of different modes of cell-division.*

Ans. There are various processes by which the cells divide. The following may be the different processes :—(1) Ordinary



cell-division, (2) Reduction division, (3) Free cell-formation, (4) Budding or gemmation.

(1) Ordinary cell-division :

Here the nucleus of the mother cell divides itself into two by a complicated process called **karyokinesis** or **mitosis** or **indirect nuclear division** and round each of these a new cell-wall is formed. Thus two daughter cells are formed out of one mother cell. These cells again repeat the process and many cells are formed.

In karyokinesis the following phases may be observed during nuclear changes :—

(a) *The Prophase.* (b) *The metaphase*
(c) *The anaphase.* (d) *The telophase.*

Prophase :

The nucleus swells up. The chromatin network thickens, recoils, and finally breaks up into a number of 'U' or 'V'-shaped parts called **chromosomes.** The nuclear membrane as well as the nucleous disappears (1—4).

Metaphase :

A number of extremely fine cytoplasmic fibres appearing from the opposite points or poles produce a thick tangled layer round the chromosomes in the form of a spindle called nuclear spindle Some of the fibres are found attaching closely to the chromosomes and are called the **traction fibres** Other fibres known as **supporting-fibres** run freely from pole to pole The chromosomes now each split up longitudinally into two and arrange themselves in the centre of a spindle to form equitorial plate (5—6).

Anaphase :

The half-chromosomes are completely separated in this stage and each of them travels towards the respective end or pole of the spindle with its apex directed towards the pole This process is performed by the activities of the traction-fibres. (7—8).

Telophase :

On reaching the poles the chromosomes condense to form two daughter nuclei. The nucleous reappears as well as the nuclear membrane. [redacted]toplasmic b[redacted]pear on the [redacted]rds the central plane o[redacted]ndle. Lastly, a new partition cell-wall is secreted in the regi[redacted] protoplasmic granules. Thus two cells are formed (9)

2) Reduction division or Meiosis :

It occurs at the time of gametogenesis or production of sex-cells The daughter cells produced by this division contain only half the number of normal chromosomes. It is therefore known as **reduction division** During this process chromosomes come together at the equitorial region and [redacted]nge themselves in pairs in such a way that the nucleus appears to contain half the normal number of chromosomes, *but these are really the double chromosomes* In the next stage two chromosomes of each double chromosome separate and each separated half goes towards each pole of the nucleus

Then the cell divides as usually Each daughter cell thus produced contains half the normal number of chromosomes. The next division is **post-meiotic** which follows the meiotic division without a resting stage This division is performed ordinarily by meiotic division The gametes or sex-cells thus produced restore the original number of chromosomes on fertilisation.

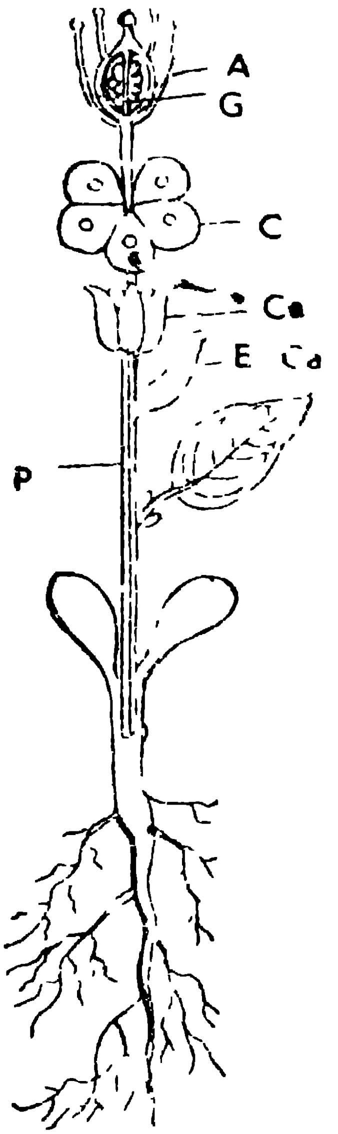
(3) Free cell-formation :

In this process the nucleus in a cell first divides into a number of parts by karyokinesis and the protoplasm collects round each of such daughter nucles and thus many cells are produced. New cell-wall may be formed or may not be formed. When no cell-wall is formed, the cells remain naked. Free cell-formation is well observed during the formation or development of endosperm.

(4) **Bu[redacted]r gemmation**[redacted]is process many protuberances[redacted]m to grow from the [redacted]nucleus di[redacted]nto as many parts as there are protuberances and each part of the nucleus goes into each protuberance. Gradually these get bigger and bigger till they cut off from the mother cell by the constrictions of the cell-wall at their junction This sort of multiplication is seen in yeast when the sugar solution is in abundance

Q 3 *Draw a diagram of a typical flower and label its parts.*

Ans By a typical flower we mean a free, simple, actinomorphic, regular flower having four **whorls.** The 1st and 2nd whorls are known as **calyx** and **corolla** and together constitute the non-essential or enveloping part of the flower The 3rd and 4th whorls are called **andrœcium** and **gynæcium** respectively. These two together constitute the essential or reproductive part. The members of the calyx are called **sepals,** of the corolla called **petals**



P = Flower stalk.

E, Ca = Bract.

Ca = Calyx

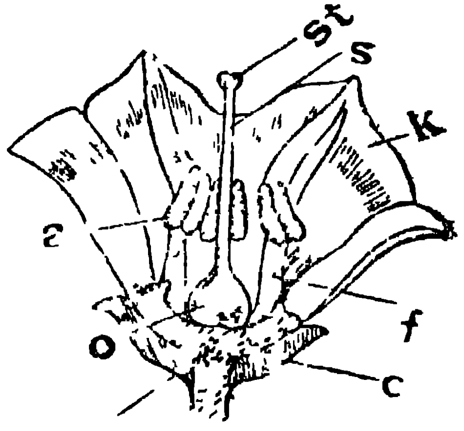
C. = Corolla.

G. = Gynæcium

A. = Andrœcium

S. = Stigma.

Diagrammatic representation of a flower showing its various parts.



c = Calyx. t. = Thalamus.

o = Ovary. f = Filament.

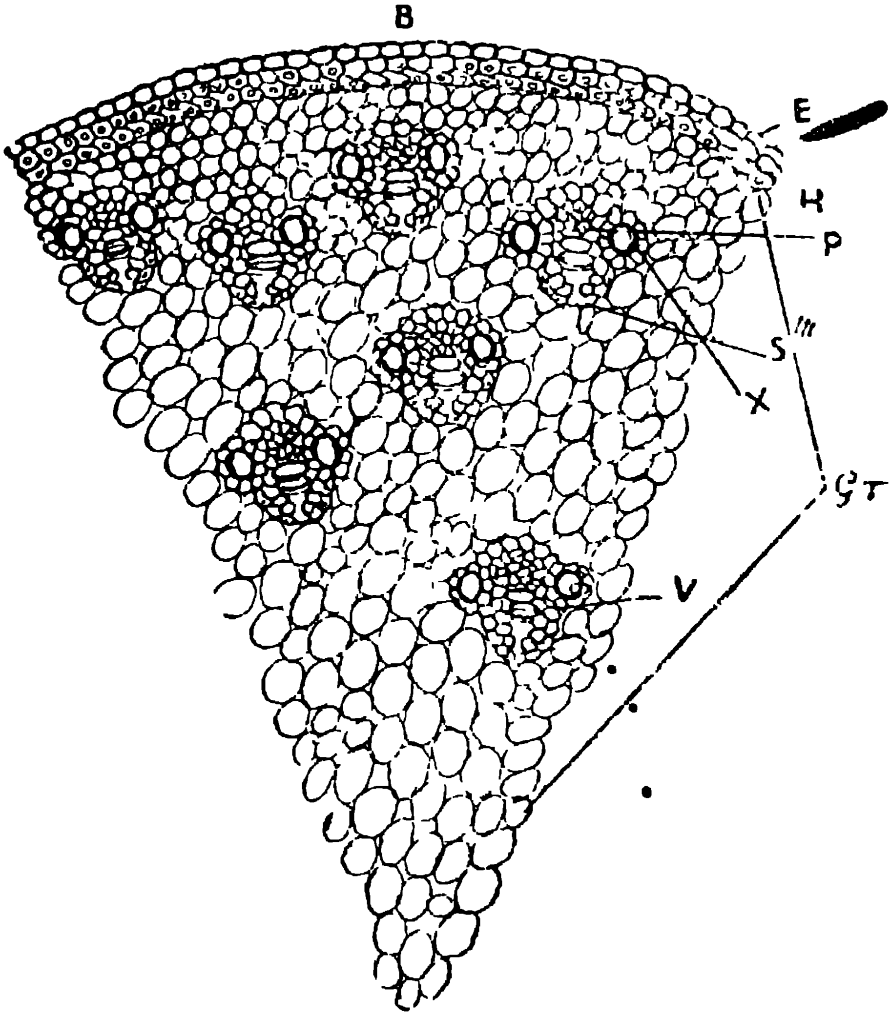
a = Andrœcium.

s. = Style. st. = Stigma.

and the members of the [redacted]cium and gynæciu[redacted] are **stamens** and [redacted]. Each stamen consists [redacted] parts—*filament, connective* and *anther*. There are also three [redacted] each carpel. These are—*Ovary, style* and *stigma*.

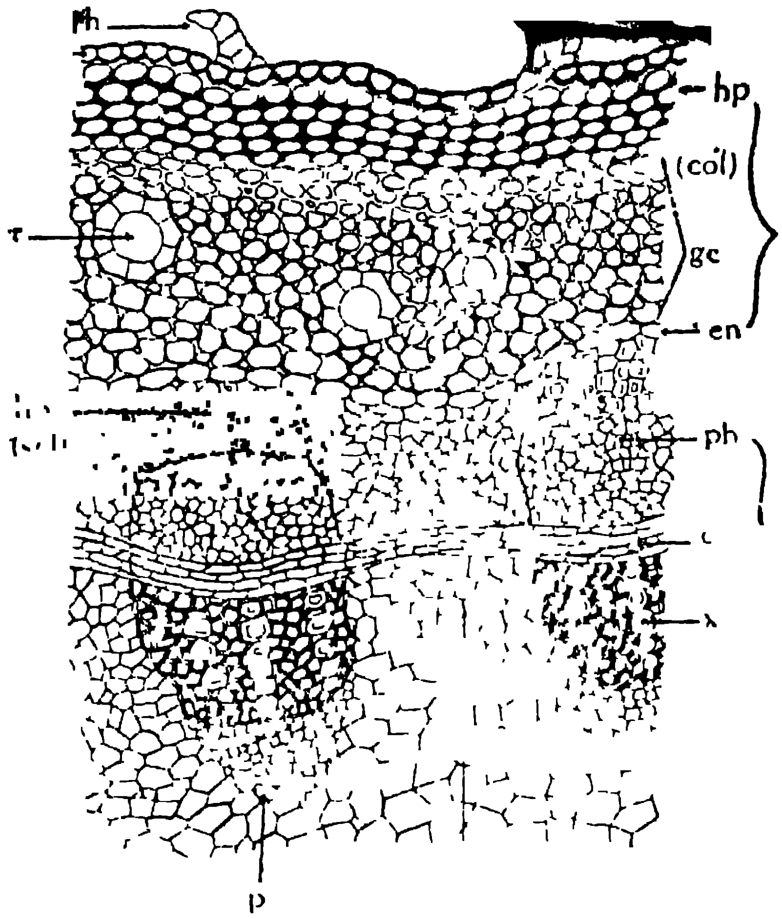
Q. 4. *Draw transverse sections of monocotyledonous and dicotyledonous stems and label the parts.*

Ans.



Transverse section of a monocotyledonous stem.

E = Epidermis. H. = Hypodermis. G t. = Ground tissue. V. = Vascular bundle. X. = Xylem (bigger pits are metaxylem and smaller ones protoxylem). P. = Phlœm, S. = Bundle Sheath.



Transverse section of a dicot stem (young).

H.—Hair, Ep.—Epidermis, Hp.—Hypodermis; **Col.**—Collenchyma, Gc.—General cortex, R.—Resin duct; **Cor.**—Cortex, En.—Endodermis, Hb.—Hard bast, Ph.—**Phlœm**; C.—Cambium, X.—Xylem, Vb.—Vascular bundle, **mr.**—Medullary ray, P.—Pith

Q. 5. *Give an account of the life-history of Spirogyra.*

Ans. Spirogyra is a green slimy algæ It is a thread-like unbranched filament and each thread consists of a single row of cylindrical cells generally separated from one another by a transverse wall called **septum** When microscopically examined some spiral bands of chloroplasts are seen in which are embedded some ovoid bodies called **pyrenoids**.

The chloroplasts manufacture sugar and convert that into tarch. [redacted]p the starch thus pr[redacted]d within heir bodie[redacted] is suspended in the middle o[redacted]cell by **protoplasmic threads** connected with a protoplasmic layer *lining the cell. The central portion of the cell within the protoplasmic* layers is occupied by a **vacuole** full of **cell-sap**.

Reproduction :

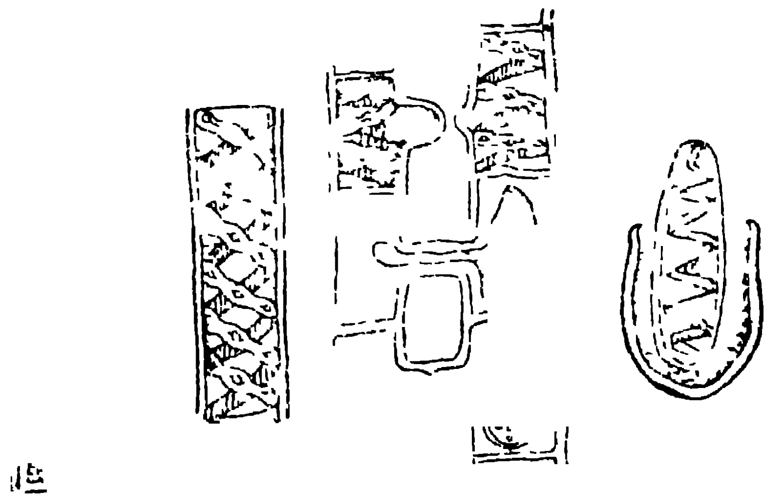
Both a-sexual and sexual reproductions are known.

A-sexual —

Each individual cell of a single filament becomes detached from other cells and grows into a new filament by repeated cell formation

Sexual ·—

Under unfavourable conditions this process is carried on by conjugation Two filaments come close to each other The adjacent cell-walls of the two filaments begin to protrude towards each other until they meet together Next the partition-walls of the cells are absorbed and a free passage known as **Conjugating tube** between these two cells is established. The protoplasm of each cell becomes contracted from the cell-wall and becomes rounded off to form **gamete** One of these rounded masses of protoplasm passes into the other through the free passage. Now these two fuse together into a round mass and secretes a cell-wall and comes out of the wall. This is called a



1-2. Filaments showing chloroplasts and pyrenoids.

3. Conjugation between two filaments showing conjugating tubes and Zygospore.

4 Germination of Zygospore.

Zygospore [illegible] is dark brown in colour [illegible] has thick cell-wall. This, under favourable circumstances, germinates into a new spirogyra plant. When the cells in a filament are all of one sex, the result of conjugation is like *ladder*, the conjugating tubes forming the rung. When the cells of the same filament are not of the same sex, conjugation between neighbouring cells of the same filament takes place. This type of conjugation is called *lateral.*

N.B.—Parthenogenetic reproduction is also known in spirogyra when however the process of conjugation fails, in such condition each gamete surrounds itself with a thick wall and form an a-sexual spore called **azygospore** which develops into a new plant.

Q. 6. *How does a plant respire? How would you demonstrate?*

Ans. Respiration :

Every plant must respire in order to live or, in other words, must break down complex substances to simpler ones in order to get energy for its own use The process of respiration is carried on by the protoplasm and the process of oxidation extends over the prepared organic substances in plants which are broken down into simpler substances Ordinary respiration involves an in-take of oxygen and an output of carbon dioxide, thus the process of respiration is a process of oxidation whereby plants derive energy and get rid of many useless or harmful products.

(1) **Aerobic**—During this process free oxygen of the air is utilised fully by the oxidisable substances present in the cell forming carbon-dioxide and water Sugar is oxidised into water and carbon-dioxide during this process Thus a plant loses its dry weight by respiration.

$$\underset{\text{(Glucose)}}{C_6H_{12}O_6} + 6O_2 = 6H_2O + 6CO_2.$$

(2) **Anaerobic respiration**—This takes place only in oxygen free medium. During anaerobic respiration a plant tries to decompose the medium to derive oxygen or breaks down some of its own tissues for the purpose.

Thus to sum up the facts we have during respiration, plants

(1) Take in or absorb oxygen ,

(2) Give out carbon dioxide and moisture ;

(3) Derive kinetic energy ; and

(4) Loses in dry weight.

Respiratory or[illegible]e process of respiration :

Plants possess no definite respiratory organs but stomata, lenticels and intercellular spaces help in the process. Respiration takes place *in every living cell at all times.*

The air containing oxygen enters into the plant body through stomata and lenticels and then passes into the intercellular spaces Now air diffuses into and oxidises the oxidisable substances present in them. The carbon dioxide and moisture come out of the cells into the intercelluar spaces and finally pass to outside through the lenticels and stomata.

An experiment showing respiration.

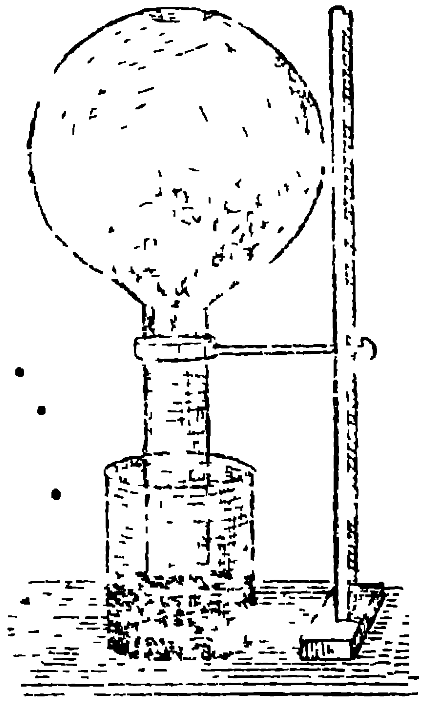
Experiment ·

Take a flask. Place within it some fresh flowers or germinating gram seeds Fill the flask with pure oxygen. Invert it over a trough of mercury. Note the level of the mercury in the neck of the flask which is kept well supported by a stand. Put the whole thing in perfect darkness to avoid any photosynthesis. Wait for over 15-20 hours

Observation :

(1) After 15-20 hours see the level of the mercury in the flask It maintains the same height. Thus the pressure within the flask remains constant.

(2) By means of bent tube pass a piece of caustic potash stick within the flask above the mercury level. After some time the level of the mercury rises in the flask due to the absorption of carbon dioxide. The residual gas can be proved to be oxygen. The volume of this residual oxygen is obviously less than the volume of oxygen with which the experiment was started.



Respiration.

Inference :

The fresh flowers or the seedlings had been respiring in the flask. They have given out carbon dio[illegible]uring the process as proved by the action of caustic potash They have taken in oxygen during the process as proved by noting and comparing the volumes of oxygen in the flask before and after the experiment.

Thus it is conclusively proved that *during respiration plants take in oxygen and give out carbon dioxide*

Q 7. *Write short notes on* (*a*) *Conjugation,* (*b*) *Oospore,* (*c*) *Prothallus,* (*d*) *Cotyledon.*

Ans. (*a*) **Conjugation :**

It is a process of new cell formation Two similar gametes or sexual cells unite so that the protoplasm of one unites with the protoplasm of the other and nucleus of the one with the nucleus of the other completely This fused mass secretes a cell-wall round it and forms what is known as the zygospore. This is found in spirogyra, mucor etc Here it must be noted that out of two cells only one cell has been formed.

(*b*) **Oospore** ·

In this process of fertilization two dissimilar gametes or sexual germ cells, male and female, unite and completely fuse together to form a product called an oospore In all phanerogams this process of reproduction is known

(*c*) **Prothallus**

A prothallus is a green heart-shaped plate-like body with small root-like processes known as **rhizoids** developing from its under surface It contains the sexual organs and gametes It represents the sexual or gametophytic stage of the plant, and develops from a spore, *e g.* in Fern.

(*d*) **Cotyledon :**

A cotyledon means a seed-leaf When the seed coats are completely peeled off, generally, two fleshy structures are exposed These fleshy lobes are called cotyledons or seed-leaves. Within the cotyledons lies the embryo or the infant plant They help in the nutrition of the plant directly or indirectly during its germination

In some seeds there are two or more cotyledons and in other there is only one Thus they may be called dicotyledonous or polycotyledonous and monocotyledonous, accordingly.

SECOND PAPER

Q 1 *Give an account of the main differences between the ving and the non-living matter.*

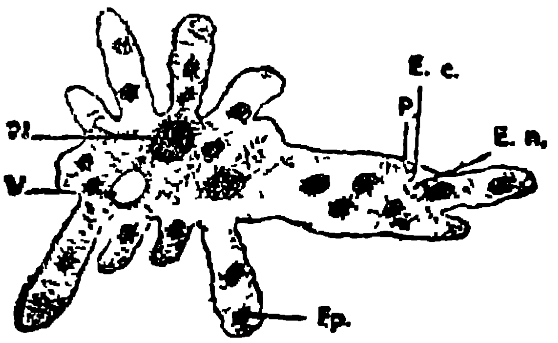
Ans

LIVING	NON-LIVING
tructure	**Structure**
1 Living bodies are **iorphous**, *i.e.*, have some efinite form	1 Non-living bodies are **usually amorphous**, *i.e.*, have no definite form
2 Living bodies are made p of cellular structures, each ll of which contains life-bstance, the **protoplasm**.	2 Non-living bodies are usually not made up of **cellular** structures and never contain **Protoplasm**.
rowth	**Growth**
3 Living bodies take food om outside and grow from side (**intrinsic growth**)	3 Non-living bodies never take food from outside and **do** not grow from inside If any growth occurs, it must be from outside (**extrinsic growth**)
etabolism	**Metabolism**
4 Living bodies have the ower of respiration, digestion, bsorption, excretion and movement, *i e*, they can perform **etabolism** (Metabolism is he sum-total of the chemical hanges going on within the ody. It consists of two processes—*Katabolism* or destrucive process and *Anabolism* or onstructive process).	4 Non-living bodies cannot perform **metabolic activities** like respiration, digestion absorption excretion **and** movement.

LIVING	NON-LIVING
Rhythmicity . 5. Living bodies show alternate activity and rest during their life-time This fact is known as **Rhythmicity**.	**Rhythmicity** : 5. Non-living bodies neve show **rhythmicity**.
Irritability 6. Living bodies can respond definitely to any stimulus given from outside **Irritability** is the characteristic of the living objects.	**Irritability** · 6. **Irritability** is not the main characteristic of the non-living objects though late Sir J. C. Bose showed that some metals can be agitated by the application of different chemicals, electrical shock, etc.
Reproduction 7. Living bodies can reproduce their kinds	**Reproduction** 7 Non-living bodies cannot reproduce their kinds.
Duration 8. Living bodies have a **'limited duration of life,'** *i e* , they start life, grow, reach a maximum size and efficiency , then show the signs of decay and ultimately die.	**Duration :** 8. Non-living bodies, if placed carefully, remain as they are for indefinite length of time

Q. 2. *Describe the various structures of an amœba*

Ans.



P. = Pseudopodium.
E. c. = Ectoplasm
E. n = Endoplasm.
N = Nucleus
V. = Contractile Vacuole.
E. p. = Food particles.

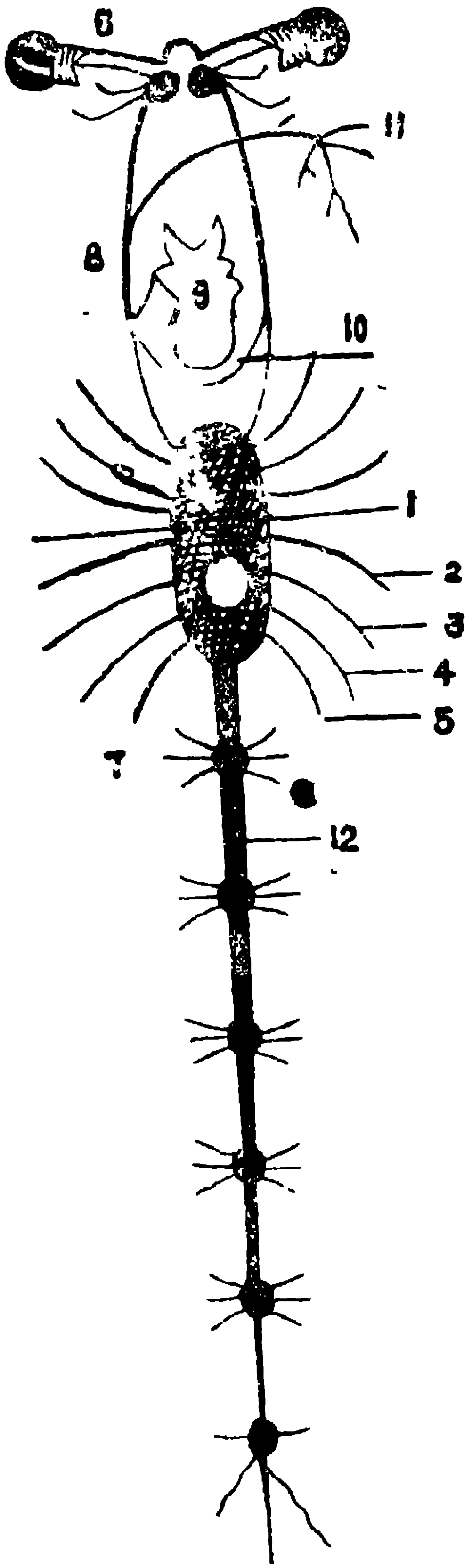
It is a very simple 'unicellular animal belonging to the group, **protozoa**. It consists of a small mass of naked **protoplasm** which varies in form from moment to moment.

When seen under the microscope it appears as an irregular translucent mass of jelly-like substance. The outer layer of protoplasm is the clear **ectoplasm** and the inner layer is the granular **endoplasm** containing numerous granules. The protoplasm lies within a delicate limiting membrane known as **plasmolemma.** It is never constant in shape and form owing to its protrusion of blunt lobes. These may be pushed out from any part of the surface, and are called **pseudopodia** or false feet. When the animal wishes to move in a certain direction a large pseudopodium is protruded in that direction.

Pseudopodia are also thrust out towards the particles of food. These grow out and envelop the food which afterwards become enclosed in the body of the amœba.

Within the endoplasm is seen a bright spherical and granular body called the **nucleus.** Many ingested food materials are also seen in the endoplasm There might be seen big clear spherical bodies within the mass of protoplasm, called the **food vacuoles** Another type of vacuole of much larger size may be seen in the mass of the endoplasm and this is called the **contractile vacuole.**

If watched, it will be seen that the contractile vacuole changes in size and gradually grows until it reaches a maximum size. Afterwards it suddenly contracts and disappears The process of expansion and contraction goes on alternately As one contractile vacuole contracts, the waste products are excreted, and another begins to form in the protoplasm. This is the excretory mechanism of the animalcule. The contractile vacuole also serves as the respiratory and water-regulating organ. When the stage of reproduction is reached, some changes in the structure appear.



[illegible] *Draw and describe the nervous system of fresh-water Prawn*

Ans. The nervous system of fresh-water prawn (palæmon) is composed of the **brain** represented by a pair of **supra-œsophageal ganglia** connected by a pair of **circum œsophageal connectives** with a ventral gangliionated nerve-chain which persists ventrally along the mid-line throughout the length of the body and gives branches to each body segment

1-5 = Nerves to the five thoracic legs
6 = Brain or Supra-œsophageal ganglia.
7 = First abdominal ganglion
8 = Circum œsophageal connectives
9 = Oesophagus
10 = Post œsophageal loop
11 Gastric ganglion
12 = Double ventral nerve cord

The brain is represented by two **supra œsophageal ganglia** which lie in the anterior region of the cephalothorax, behind the eye stalks and beneath the rostrum Each supra-œsophageal ganglion gives off three branches on each side ·

(1) One supplying the eye, called optic nerve.

(2) The second supplying the first antenna below the optic nerve.

(3) The third supplies the second antenna Along with this nerve another small nerve supplying the labrum also arises from the supra-œsophageal ganglia

The supra-œsophageal ganglia are connected with the thoracic ganglionic mass by means of two big branches Each of them lies on each side of the œsophagus. Then behind the œsophagus they join and is then called the **circum-œsophageal connectives** , each circum œsophageal connective gives off fine nerve which joins together to form a loop behind the œsophagus. This goes by the name of **post œsophageal loop**

Posteriorly the circum œsophageal connectives unite with a big ganglionic mass which is pierced posteriorly by the sternal artery. This mass gives off branches to all the appendages except the two antennæ This is called the **thoracic ganglionic mass.**

From the posterior part of the thoracic ganglionic mass begins the ventral abdominal nerve cord This gives off six other ganglia, each corresponding to each body segment of the prawn From each ganglion, fibres are given off to the corresponding segmental muscle. The ventral ganglionated nerve cord is really double in origin

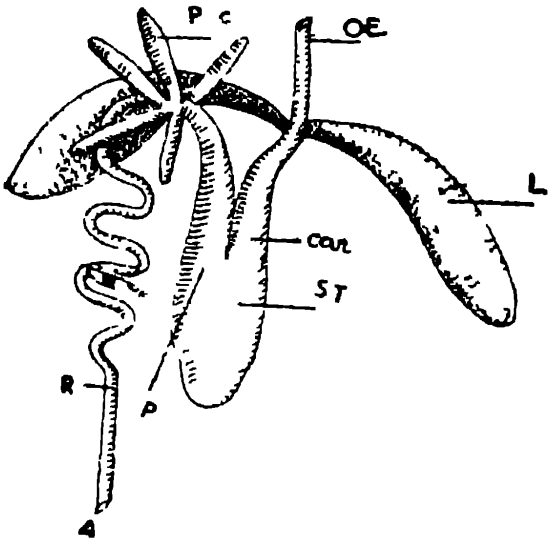
There is another system of nerves in prawn, called **visceral nervous system**. A special nerve ganglion called gastric ganglion is placed between the space of the anterior gastric wall and the cerebral ganglia. It is connected with the circum-œsophageal commissures and the post œsophageal loop at their junction The sixth ganglion supplies the sixth segment and also the lower part of the intestine. Hence it is called **sub-intestinal nerve**.

Besides the above-mentioned central nervous system a symphathetic nervous system comprising of a number of ganglia in connection with the viscera is also very prominent

Q 4. *Draw and describe the alimentary system of Bhetki.*

Ans. It has a wide mouth bounded above by the upper jaw and below by the lower jaw. The upper jaw is formed of the premaxillæ and maxillæ bones. Inside the mouth cavity there are teeth growing on maxillæ, premaxillæ, vomer and palatine bones and also on the dentaries.

On the floor of the mouth cavity (buccal cavity) is the short and immovable tongue. The buccal cavity is continuous behind with the pharynx. On the lateral walls of the pharynx are seen the gill-clefts.



Oe =Oesophagus.

L. =Liver.

P C=Pyloric coeca

Int =Intestines.

R =Rectum.

A =Anus.

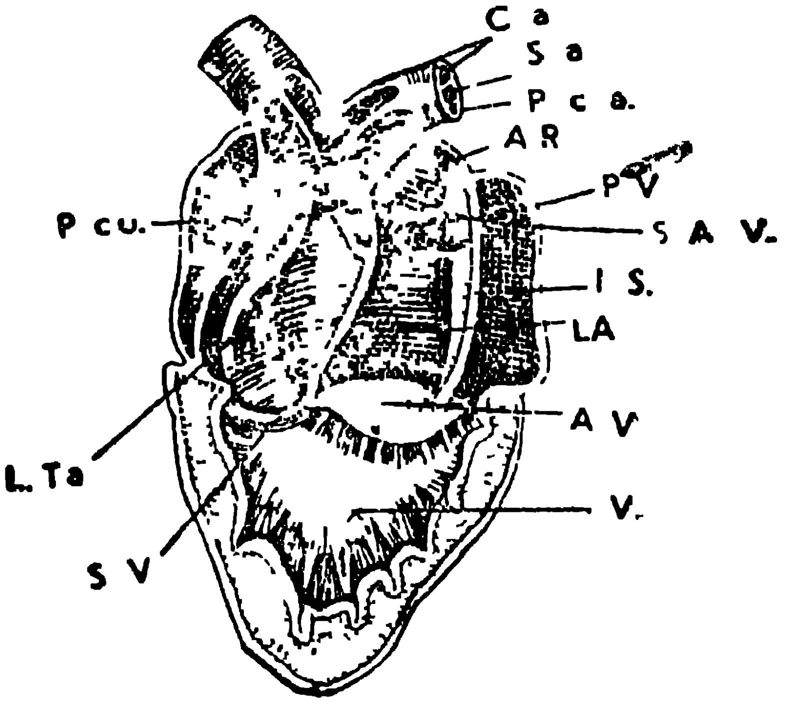
The pharynx leads posteriorly into the œsophagus. It is a tube passing into the abdominal cavity where it is continuous with the **stomach**.

Stomach is a V-shaped bent sac produced behind into a blind pouch The portion of the pouch which is continuous in front with the œsophagus is called the **cardiac end**. The other limb of the V-shaped pouch, called the **pyloric end** which is continued with the intestines. Just at this point is a ring-like construction called pylorus At the beginning of the intestines which is a much-coiled tube there are five finger-like processes called **pyloric coeca** These probably serve the functions of pancreas The intestine extends posteriorly After this begins the large intestine called the **rectum** and ends into the **anus**.

On the ventral aspect of the stomach lies the liver, a large gland It extends backwards as two leafy lobes of which the left being the longest The gall-bladder is placed upon the left lobe and is connected with that by a duct called hepatic duct. Another small duct issues out of the gall-bladder and giving a short dilatation joins the intestine near the junction of the intestine and the stomach This is the cystic or bile duct. There is no separate pancreas in Bhetki.

Q. 5 *Draw a diagram of a dissected heart of a Toad and label the positions of the various apertures and valves.*

Ans



S a = Cavum systemicum ,
C a = Cavum caroticum ;
P C a = Cavum pulmocutaneum ,
A R = Right auricle
P V = Opening of the pulmonary vein ,
S A V = Sino-auricular valve ;
I, S = Inter auricular septum ,
L A = Left auricle ,
A V = Dorsal flap of auriculo ventricular valve ,
V. = Ventricle , S. V = Semi-lunar valve ,
L Ta = Spiral valve of truncus arteriosus ,
P Cu = Pulmo-cutaneous opening

Q 6 *Compare the bones of a fore limb with that of a hind limb of a Guinea-pig*

Ans

A. **Fore limb**

The fore limb of a Guinea-pig consists of the following —

(1) One long bone called the **humerus** forming the bony structure of the arm. It articulates above with the scapula by

its globular head and below by the **trochlea** with the bones of the fore arm. Below the head of the humerus on the anterior side, there is a longitudinally placed **bicipital groove** This is bordered on the inner side by the **lesser tuberosity** and on its outer side, by the **greater tuberosity**

(2) Two long bones · One called the **radius** lying in the front and another, the **ulna** behind and below, forming the skeletal structure of the fore arm.

(3) Wrist is formed of six small bones called **carpal** bones arranged in two rows, proximal and distal with a central one interposed.

(4) Next to the wrist bones are the four **metacarpal** bones, with four digital bones containing phalanges Each digit ends in a claw.

B. **Hind limb** ·

The hind limb consists of the following on each side —

(1) Thigh bone or **Femur** forming the hip bone It is an elongated bone and its head articulates with the acetabulum to form hip joint. There are other three heads, the **greater trochanter** on the outer side, the **lesser trochanter** to the inner side, and opposite to that lies the **third trochanter** There are two **condyles** in the lower end which articulate with the upper end of the tibia. The **patella** is a large bone developed on the tendon and serves as the knee-cap

(2) The leg is formed of two bones :

(*a*) Tibia—a long stout bone with a prominent **enemial crest** in front.

(*b*) Fibula—a slender bone distal to tibia.

(3) Distally to these fused bones is the *ankle* region formed of **tarsus** bones, arranged in two rows with a central one interposed. The first row contains

(*a*) **Astragalus** or tibiale.

(*b*) Calcaneum or fibulare.

The second row contains several imperfectly ossified bones.

Next are the *three metatarsal* bones ending in three toes each containing three phallanges ending in a claw. The first toe is called the *hallux.*

BONES OF THE FORE LIMB	BONES OF THE HIND LIMB
1 Upper end of the humerus articulates with a cup-shaped cavity known as glenoid cavity in the pectoral girdle by a head Below the head on the anterior side a longitudinal groove bordered by greater and lesser tuberosities, is present It articulates with the bones of the fore arm by the trochlea.	1 Upper end of the femur articulates with a cup-shaped cavity called acetabulum in the pelvic girdle by a head. It has other three heads, the greater, lesser and third trochanter in the upper region and it articulates with the next bones by two condyles.
2. No bone similar to patella or knee-cap is present.	2. Patella forms the knee-cap.
3 The next distal bones are radius and ulna. Radius lies in front and ulna below	3. The next distal bones are tibia and fibula. Tibia is a long stout bone with a prominent enemial crest in front. Fibula is a slender bone distal to tibia
4 Wrist joint is formed of very small bones in two rows with a central one interposed	4 Ankle joint is formed of very small bones in two rows with a central one interposed. The proximal row contains two fairly big bones but the others are small.
5 Metacarpal bones, four in number	5. Metatarsal bones are three in number.
6. Four digits.	6 Three toes.

Q 7 *Give a few morphological examples by which you can show the evidences of organic evolution.*

Ans. If we study the external and internal characters of animals marking the gradual complexities they attain from the protozoa to metazoa, we are convinced that the simpler organisms are the ancestors of the complex ones.

All the protozoa carry on their vital activities of life in one cell as in amœba

Again if a hydra be examined, it is seen consisting of two-layered cells Similarly an annelid, a leach for example or an earthworm, has its body consisting of three layers of cells. As the layers of cells become more in number, the complexities of tissues begin to supervene Thus in arthropoda the tissue-complexity is more than that in annelida and still more in vertebrata and craniata There are other parts of the body also which might be noticed in a more modified character which appear useless But if traced downwards it might be seen that these were of use in the animals of lower grade The external pina of man, which is fixed, is the vestigeal remains of that possessed by the other animals who can move it to catch the sound from different directions

If the character of pentadactylity is considered, we find the same plan in the amphibians, reptiles, birds and mammals Thus this plan can be considered as modifications in the paired appendages of common forefather If we consider the hearts of fish, toad and guinea pig, we find gradual complexities envolved in them Fish has no fore limbs or hind limbs but a crocodile or a toad has both the sets of limbs Thus from fish to toad or crocodile the tracing line becomes more and more complex.

The external or internal structures of the animals and similarly of plants bear sometimes a homologous and sometimes analogous character in them in the course of their evolution and thus bear the morphological evidences in the roll of organic evolution

— —

1937

FIRST PAPER

Q. 1. *What are the characteristics of living matter ?*

Ans. Living matter shows several characteristics and they are as follows :—

1 Form :

All living matters possess **definite forms.**

2 Protoplasm :

All living matters possess what is called **Protoplasm** which is known as the physical basis of life. This protoplasm is always found within special compartments called cells.

3 Nutrition and Growth

Nutrition is another peculiarity of the living bodies. The food materials taken up by the living matters are utilised in building up of their own bodies and thus the living matters grow in bulk Such increment in bulk is known as **growth** and as it takes place from within, this growth is said to be of **intrinsic type.**

4. Movements :

Various kinds of movements are seen in the living matters.

5 Respiration :

All living matters take in oxygen and give out carbon di-oxide during their life-time This process serves some important physiological purposes of the body and is known as breathing or **respiration**

6 Secretions and Excretions :

Secretions and **Excretions** are also the two processes carried on by a living body, the former being re-utilised and the latter thrown away by the body

Thus all living bodies carry on process of **metabolism** which consists of two processes , (*i*) anabolism or constructive process and (*ii*) catabolism or destructive process.

7. Reproduction :

All living matters possess what is called the power of **reproduction.** They, from time to time, give rise to new individuals like themselves which repeat the same phases in life as their parents.

8. Rhythmicity :

All living matters show active and inactive life alternately. This phenomenon is called **rhythmicity.**

9. Irritability

All living matters show **irritability**, *i e*, they readily respond to the external stimulus

10. Senescence ·

Lastly, all living matters must wither, get old and gradually decay This is known as **senescence.**

Q. 2. *What is cell, and what is a tissue? Describe Sieve-tissue.*

Ans For cell see Ans. to Q 1, 1st Paper, 1935.

Tissue :

Tissue is an aggregation or collection of several cells arising from the same origin, and possessing similar structure and similar function.

Sieve-tissue :

Sieve-tissue or phloem tissue mainly consists of seive-tubes or vessels along with companion cells, some parenchyma and bast or phloem-fibres **Sieve-tubes** are vessels attached end on end. The lateral walls are thin and consist of **cellulose** The walls of the vessels towards the ends are thickened and a layer of **protoplasm** is usually seen adherent to the walls of the vessels but no **nucleus** The end walls separating two vessels are not only thickened but are perforated like sieve and form what are known as **sieve-plates.** In gymnosperm and pteridophyta plates are found on the lateral walls In some other cases the plates are also placed obliquely These sieve-tubes cease their functions temporarily or parmanently due to the formation of a cap-like structure called **callus**, on the surface of the sieve plate The sieve-tubes are often filled with starch and nitrogenous matters.

The sieve-tubes are often connected with thin-walled asymmetrical and somewhat modified parenchymatous cells called **companion cells** by means of small pits. Each of them is rich in cytoplasm, small vacuoles and conspicuous nucleus. The companion cells never contain starch grains and assist sieve-tubes in the conduction of food. They are absent in pteridophyta and gymnosperms The cells of the **phloem parenchyma** consist of vertically elongated cells Their chief functions are (i) translocation of sugar and diffusible proteids, (ii) storage of substances and (iii) helping in the transportation of food from the sieve-tubes to the medullary rays and other parts Phloem parenchyma are differentiated from the procambium **Bast** or **phloem fibres** are found in secondary phloem of angiosperms, but they are absent in pteridophytes, gymnosperms and in a few herbaceous angiosperms These are made of groups of greatly elongated cells usually with narrow, pointed opposite ends The walls of these cells are uniformly thickened and their lumens due to such extreme thickening become narrow The walls are generally hard and lignified and are characterised by having linear or rounded simple pits The cells when mature are usually dead

Q 3 *Describe the storage of reserve food materials in plants that are known to you*

Ans Reserve food materials in plants occur in their various parts, such as leaves, stems, roots fruits and seeds.

The food materials that are generally found reserved in plants may be divided into *three* broad classes —

1 **Carbohydrates**—Sugar including cane and grape-sugars, starch and inulin

2 **Proteids and Amides**—Aleurone grains and albumins.

3. **Fats and Oils**—As fixed and non-volatile oils.

I *Reserved food contained in the* **leaves** *may be as follows* —

A **Carbohydrates** .

(1) Grape-sugar—In Mithapan, fleshy scale leaves of Onion.
(2) Starch—In the cotyledons of Pea, Gram.

B. **Proteids and Amides** :

(1) Aleurone grains—In the cotyledons of Pea, Pulses
(2) Amides—In the form of soluble protein in every leaf.

C. **Fats and Oils**

(1) Oils—In the cotyledons of Groundnut, Mustard, Cotton.

II. *Reserved food materials contained in the* **stems** *may be as follows*, -

A. Carbohydrates :

(1) Grape-sugar—In the Onion.
(2) Cane-sugar—In the Sugarcane.
(3) Inulin—In the Artichoke
(4) Starch—In the pith of Sagopalm, Potato, Alocasia (*Mankachu*), Ginger, Amorphophallus **(Ol)**, etc.

B. Proteids and Amides :

Amides—In the form of soluble protein in every stem

C. Fats and Oils

Oils—In the form of drop-lets in the general mass of the cytoplasm.

III. *Reserved food materials contained in the* **roots** *may be as follows* .—

A Carbohydrates

(1) Grape-sugar—In Sweet Potato (*Sakarkanda*).
(2) Cane-sugar—In Beet root
(3) Inulin—In Dahlia tuber
(4) Starch—In Radish, Carrot, Sweet Potato (*Sakarkanda*).

B. Proteids and Amides

Amides—In the form of soluble protein in every root.

C. Fats and Oils

Oils In the form of drop-lets in the general mass of the cytoplasm. In orange or Lemon leaves

IV. *Reserved food materials contained in the* **fruits** *may be as follows* —

A. Carbohydrates :

(1) Grape-sugar In Mango, Apple, Plantain, etc
(2) Starch—In Rice, Maize, Wheat.

B. Proteids and Amides :

Amides—In the form of soluble protein in every fruit.

C. Fats and Oils :

Oils—In *Mohua*.

V. *Reserved food materials contained in the* **seeds** *may be as follows* :—

A. Carbohydrates :

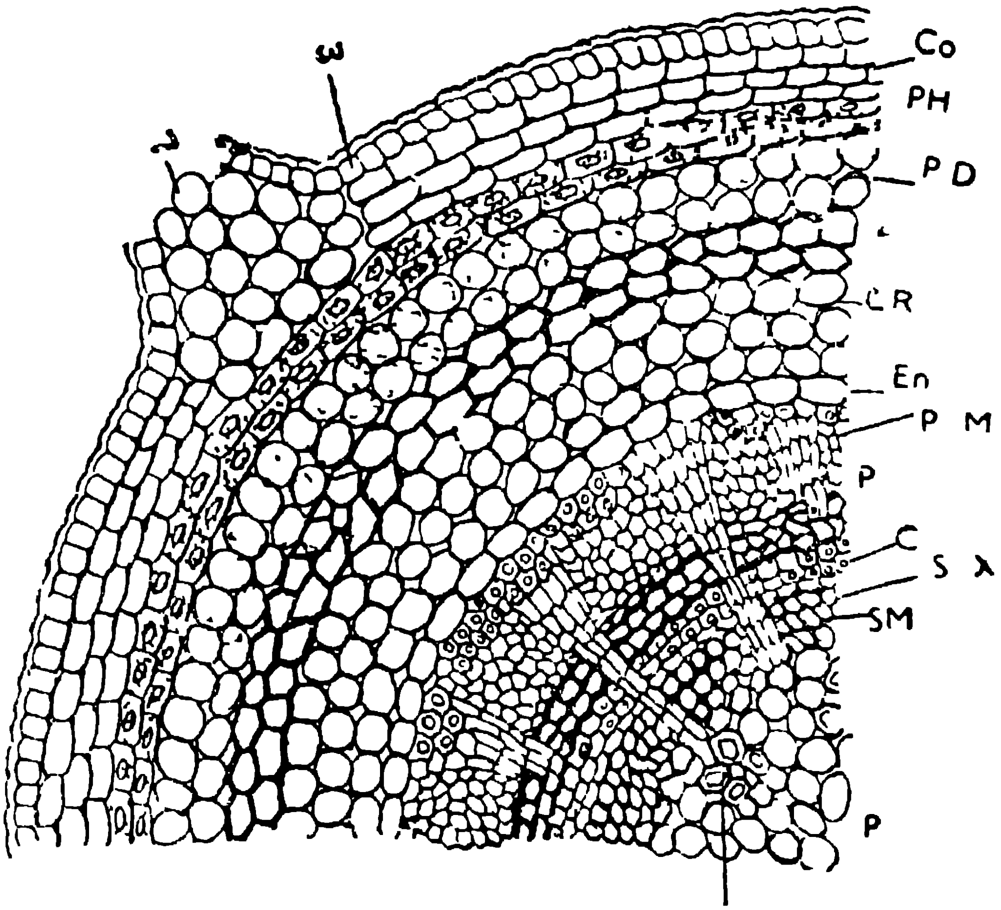
Starch—In all seeds.

Proteids :—In the endosperm of Castor.

C. Fats and Oils :—In the endosperm of Castor, Coconaut, etc.

Q. 4. *Draw and lebel the various parts of a dicotyledenous stem after secondary growth.*

Ans



L = Lenticel
E. = Epidermis ,
Co = Cork ,
PH. = Phelloderm or secondary cortex ,
PD = Periderm ,
CR. = Primary cortex ;
EN. = Endodermis ,
P. M = Primary medullary ray ,
P = Phloem ,
C. = Cambium ,
S.X. = Secondary xylem ,
S. M. = Secondary medullary ray
Pi = Pith in the centre ,
X. = Primary xylem.

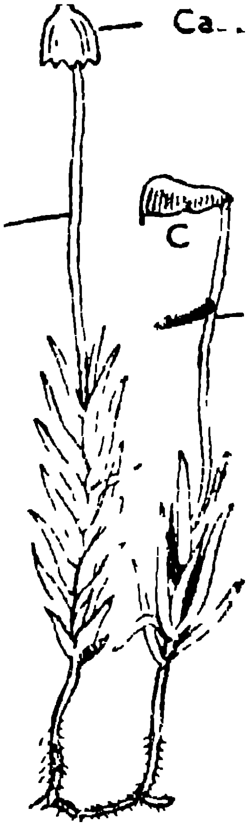
Q 5 *Compare the structure of a shoot with that of a root of a flowering plant*

Ans Several points of distinction between a root and a shoot are given in the following table —

SHOOT	ROOT
1 Grows from the plumule and ascends up	1. Grows from the radicle and descends down into the soil
2 Produces buds which may be either axilary or terminal	2 No buds are formed in roots
3 Bears similar and dissimilar members, i e , leaves and branches.	3 Bears only similar members i e , no leaves but rootlets
4 Terminal bud is formed at the apex.	4 No terminal bud bu protected by a root-cap
5. Shoot-branches originate exogenously, i e , from the superficial layer of cells	5 Root-branches originat endogenously, i.e , from th deep tissues
6 Generally reproductive organs are borne by shoot	6 No such, by roots
7. If hairs present, they are multi-cellular	7. Hairs are present always and they are uni-cellular
8 It is positively heliotropic but negatively geotropic	8. Roots are negativel heliotropic and positively ge tropic
9. Vascular bundles are conjoint.	9 Vascular bundles ar single.
10 Protoxylem is towards the centre.	10. Protoxylem is towar the periphery.

Q 6. *Give an account of the life-history of a Moss.*

Ans. Life-history of a **moss** consists of two parts. The plant that we see represents the **Gametophytic stage** and subsequently it produces the **Sporophytic stage**, called the **sporogonium**.



Gametophyte :

It occurs in woods, meadows, and walls It may be monoecious or dioecious It has a slender stem bearing small crowded leaves

The plant bears at its top male and female organs called **Antheridia** and **Archigonia.** The leaves that surround these organs are called **paraphyses** which are different from the vegetative leaves.

S =Seta ·

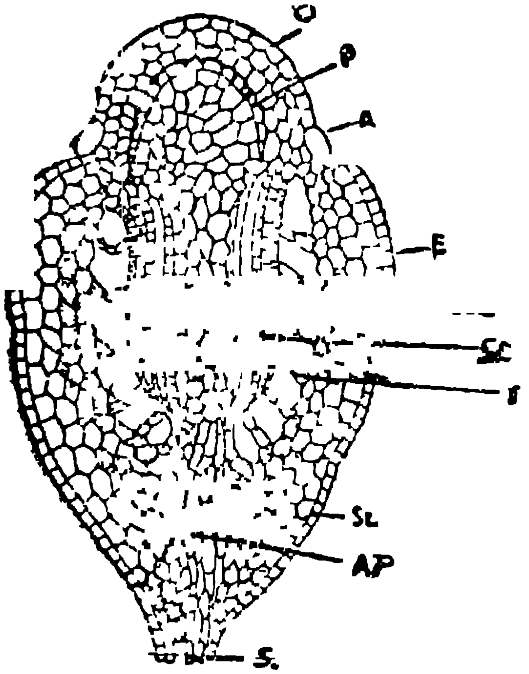
C. = Capsule ;

Ca. = Calyptra.

Antheridia are club-shaped bodies and they give rise to biciliated **antherozoids.** The archigonia are flask-shaped bodies. It has a neck above and a ventre below. When it is matured, a ventral canal cell and an **oosphere** are formed. This canal secretes a mucilagenous substance and sugar which attract the full-grown matured biciliated antherozoids. One such reaches and fertilises the ovum forming an **oospore** which covers itself with a cell-wall.

This oospore gradually gives rise to a sporogonium. Sporogonium has two distinct parts : a small head called **capsule and** a stalk called **seta** with which it is attached to the plant.

On making a longitudinal section of the capsule, the following structures are observed .—



O = Operculum ;
P = Peristome ,
A = Annulus ,
E. = Epidermis :
S C = Spore-sac ,
C. = Columella ,
T. = Trabeculae ,
St. = Stomata ,
A P = Apophysis ,
S. = Seta.

(a) The solid basal portion of the capsule known as **apophysis**, bears a few stomata and chloroplasts in a few inner cells.

(b) The middle portion of the capsule is provided with (1) a wall, known as **capsule wall** which consists of a single layer of cells inside which there are a few layers of thin-walled parenchymatous cells, the inner layers containing chlorophyll. (2 Inside the chlorophyll-containing cells there is a cylindrical **air cavity** which is traversed by delicate strands of cells, known as **trabeculae** (3) Inside the air-cavity lies the **spore-sac** containing numerous small spores , the outer wall of the spore-sac is few-layered, while inner, one-layered (4) The central solid mass of parenchyma is called **columella**.

(c) At the apical portion of the capsule lies a lid-like structure known as **operculum** It is few-layered, the innermost layer is known as **peristome** and is provided with teeth-like structure. At the base of the operculum lies a circular layer of cells known an **annulus**.

When the capsule is ripe, the operculum of the calyptra falls off and spores scatter on the ground. Columella helps the dispersal of the spores.

When favourable circumstances arrive, each spore produces a much-branched filamentous structure. This structure is called **protonema** It is green and assimilates carbon dioxide. It has rhizoids to draw the nutrition from the soil. These are not true roots From the protonema new buds develop which ultimately produce new moss plants.

Thus the plant is the gametophyte and the sporogonium is the sporophyte.

Q 7. *Write short notes on any* **four** *of the following .—*

(*a*) *Saprophyte,* (*b*) *Inflorescence,* (*c*) *Fertilization,* (*d*) *Oosphere,* (*e*) *Protonema,* (*f*) *Perederm*

Ans (*a*) **Saprophyte .**

There are some plants, generally the fungi, which derive their food-materials from dead organisms and decaying matters. They have no capacity to prepare their own food-materials from simpler elements These plants are known as saprophytes and they do not contain any chlorophyll. All fungi are saprophytes, such as Mucor, Mushroom, Yeast, etc.

(*b*) **Inflorescence** is the flowering shoot consisting of one or more flowers It may be terminal, when it is at the end of a shoot, or axillary, when it appears at the axil of a leaf. It may or may not be subtended by bracts

(*c*) **Fertilization**

This is the process in which a male gamet fuses with a female gamet to form an oospore which ultimately develops into an embryo or a seed. This process begins after the polination

(*d*) **Oosphere**

When an ovule gets matured, the nucleus divides into eight daughter nuclei Each of the two antipodal cells are represented by 3 nuclei and the rest two fuse in the centre to form the definitive or secondary nucleus. The naked cell on the inner side of the micropyler end is called the oosphere, ovum or egg cell.

(*e*) **Protonema :**

It is a much-branched filamentous structure representing the early gametophytic stage of moss. It develops from the spore after its germination.

It is green and possesses root-like structures, called **rhizoids**, and **lateral buds** The protonemal stage can prepare its own food and is quite independent of the parent : numerous leafy erect branches are produced.

(*f*) **Periderm** :

At the time of secondary growth the epidermis cannot keep pace with the growth and then internal pressure caused by the new tissues, causes the epidermis to rupture at places to provide for this new, secondary tissues and are developed usually in the cortical region which receives the name **periderm**. The periderm consists of (1) the **phellogen** or cork-cambium, which produces on its outer side, by its repeated division ; (2) a kind of highly suberised dead tissues called **phellen** or cork, and in the inner surface , (3) secondary cortex or **phelloderm**

SECOND PAPER

Q 1. *Describe a typical animal cell*

Ans. Definition :

An animal cell is a unit mass of living matter usually with protoplasm and a nucleus. All protozoa consists of one cell, *e g* , amaeba and metazoa contain many cells and usually they combine to form a tissue, *e g* , toad, guinea-pig

Structure ·

1. It contains a mass of transparent, jelly-like, colloida living substance called **protoplasm** and a non-living cell inclusions.

2. There is a nucleus or controlling body within it, which has got special structure and functions. It is always coverec by a membrane called nuclear membrane. Within the nuclear membrane a network of delicate threads made up of highly stainable substance known as **karotin** is found. There are als

two special bodies called **nucleoli**. All these structures float in a fluid called **nucleoplasm**. The general protoplasm without the nucleus is called cytoplasm.

3. No distinct cell-wall is seen in an animal cell except the cell-membrane—the **plasmolemma**. The outer portion of protoplasm is clearer and called ectoplasm and the inner portion granular, called endoplasm.

4 Another peculiarity in an animal cell is that it contains a centrosome or a star-shaped radiating structure with a central body called **centriole** especially during or just before cell-division.

5 There may be one or more vacuoles surrounded by the cytoplasm The thin hyaline layer surrounding the vacuole is called the **tonoplast** Each vacuole is filled with cell-sap.

6 There also occur some minute rod or thread-like bodies thrown into the cytoplasm These are called **mitochondria** or chondriosomes

7. Some small granular or reticular bodies are also found near the nucleus by the side of the centrosome of the cell. These are called **golgi bodies**.

8. Some small granules of protein substance called **metaplasmic bodies** or dentoplasm are also found in the cell

Q. 2. *Give a general account of the excretory system of a fresh-water Prawn*.

Ans The excretory system of a fresh-water prawn is composed of a pair of **antennary glands**, each of which is placed at the base of the corresponding second antenna The glands are green in colour when fresh and hence called **green glands**. The opening is marked by a knob-like structure called the papilla of the green gland.

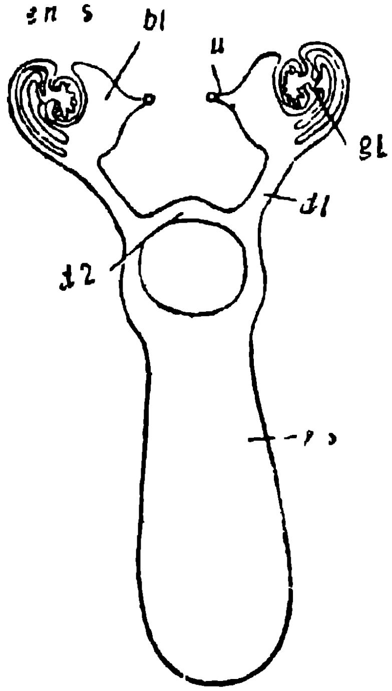
Each gland consists of the following parts :—

(*a*) an **end sac** which secretes excretory products ;

(*b*) **a glandular mass** which also secretes excretory products , and

(*c*) **a bladder** through which the excretory products are carried to outside.

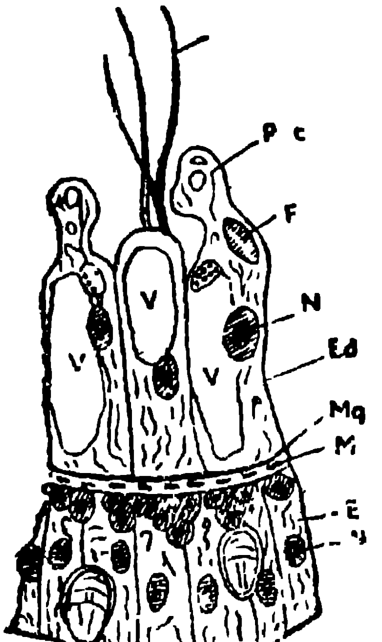
Each bladder is produced into a short tube, the **water** which opens to the outside through the inner side of the base of second antenna. Each gland is connected to a median **renal sac** by a narrow duct. This sac lies just above the cardiac stomach and serves as the temporary reservoir of the excretory substances.



Besides the green glands the **integument** is believed to be an important excretory organ. The thick chitinous integumental layer is made of non-living nitrogenous product secreted by the ectoderm. This is cast off at the time of **ecdysis** or moult casting

U.—Ureter ; bl —Bladder ; gl —Glandular mass , en. s —End-sac , d_1 d_2—Ducts , r. s.—Renal sac.

Q. 3. *Give a drawing of a transverse section through the body of a Hydra and label the various structures that could be found.*



Ans

E.—Ectoderm cells ,
M.—Muscular layer ,
Mg.—Mesogloea ,
Ed.—Endoderm cell having large vacuoles ;
V.— Vacuoles ,
N —Nucleus ;
P c.—Pseudopodia (amoeboid cell) ,
F.—Flagella (Flagellate cell) ,
F.—Food in endoderm ,
Ntc.—Nematocyst ,
C.—Cnidoblast.

The clusters of small cells found where the ectoderm meets the mesogloea are known as **Interstitial cells.**

Q 4. *Compare the external features of Bhetki with Tadpole.*

Ans.

Bhetki	*Tadpole*
Appearance of the body	**Appearance of the body** .
1. Distinct head with *two nostrils on each side* which are *not communicating* with the pharynx and a prominent mouth bearing teeth. The head is flat from side to side.	1 Distinct head *without any nostril* at first which afterwards develop as one *nostril on each side* and are *communicating* with the pharynx In the early stage no mouth is present, only a succer persists ; with development, mouth appears but never bears any tooth. The head is round.
2 Body is wider than the head and is flat from side to side It is covered with etenoid scales and possesses distinct lateral line called sense organ. Tail is distinct.	2. No distinct body is present. Scales are absent and the lateral line or sense organ is indistinct. Tail is distinct but gradually atrophies.
3. Eyes prominent.	3. No prominent eyes in early stage which afterwards develop into protruding eyes.
4. Gills are internal and the gill-slits communicate the pharyngeal cavity with the exterior Gills are the only respiratory organs.	4. In the early stages filamentous external gills persist which afterwards are replaced by the internal gills. These gills degenerate and disappear at the later stage and two lungs develop within the body.
5. Intestine is not visible from outside.	5 The watch-spring-like coil of the intestine can be seen ventrally.

Bhetki	*Tadpole*
Appendages :	**Appendages :**
6. Paired and unpaired fins are present. The pectoral and pelvic fins are paired and the dorsal, caudal and anal fins are unpaired.	6. Paired and unpaired fins are absent. A thin median fold of skin is seen above and below the tail and this might be called a tail fin.
Fore and hind limbs are absent.	The hind limbs appear first and then the fore limbs.
Apertures :	**Apertures :**
7. Mouth—Large and terminal in front and bears teeth on the jaws	7. Mouth is absent first but develops afterwards. Jaws are horny.
8. Nostrils are two on each side	8 Nostrils are absent in the early stage but develops as a pair of apertures afterwards Nasal pits are present in early stage
9. The gill-chambers are one on each side behind the head. Each of them is covered by a lid called operculum No branchial aperture is present on either left or right side	9 The gill-chambers are absent first but later on develop one on each side Each of them is covered by operculum An aperture called branchial aperture is present on the left side for a considerable time.
10. On the ventral border, towards the posterior end and in front of the anal fin a depression is seen into which the anal opening is found in front, the opening of the ureter behind and the opening of the genital ducts remain in between the two.	10. In the early stage no anal aperture is found but afterwards an aperture called vent is formed through which the faces and urine come outside The vent is really the aperture of a chamber called cloaca into which the alimentary canal ureters and genital ducts open when adult.

Q 5 *Describe the venous system of Toad.*

Ans. **Veins** are the tubular blood vessels through which blood returns from the body to the heart either directly or through the agency of some intermediate organ. There are two classes of veins called **(A) Systemic** and **(B) Portal.**

A **Systemic Veins** · Through these blood directly enters the heart or sinus venosus It consists of :

1. Two **anterior venae cavae** or **Precaval veins** opening into the sinus venosus.

2 One **posterior vena cava** or **Post caval vein** opening into the sinus venosus

3. A pair of **pulmonary veins.**

1. Each *anterior vena cava* is formed of :

(*a*) **External jugular vein** which is formed of the *lingual* from the tongue and the *mandibular* from the mandible.

(*b*) **Innominate vein** which is formed of the *internal jugular* from the brain and the *subscapular* from the shoulder.

(*c*) **Sub clavian vein** which is formed of the *brachial* from the fore limbs and *musculo-cutaneous* from the skin and some muscles of the body.

2. *Posterior vena cava* is formed of 5·6 pairs of **renal veins** from the kidneys. **Genital veins** from the genital organs and also from the **hepatic vein** that drains the lever.

3 The *two pulmonary* veins one from each lung unite together and open into the left auricle on its dorsal aspect.

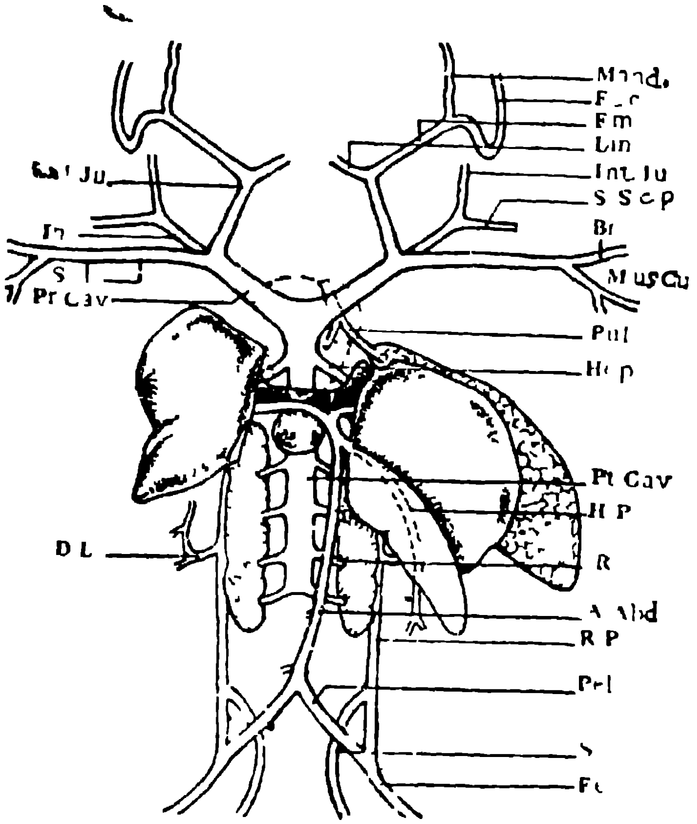
B **Portal veins** These instead of opening into the heart or sinus venosus directly, open into the intermediate organs like liver and kidneys, and form extensive branching there. Several portal veins combine together to form portal system.

As for the portal system we have *two* such sets :—

1. *Renal portal system.*
2. *Hepatic portal system.*

1. Renal Portal System :

Femoral vein from each hind limb divides into two. One goes forward and during its course receives two other veins, namely the Dorso-lumber vein from the posterior body wall and the Sciatic vein from the thigh to form the **Renal portal vein.** These, of course, open into the kidneys and form extensive branching there in order to produce Renal portal system The other half forms an arch and meets the fellow of the opposite side to form the **Pelvic vein**



Pre. Cav. = Anterior vena cava or Precaval vein, Scl = Subclavian vein, Mus cu = Musculo cutaneous vein, Br = Brachial vein, S. Scp = Subscapular vein, Int Ju. = internal Jugular vein; In = Innominate vein, Ext Ju. = External Jugular vein Lin = Lingual vein. F. M. = Faciomandibular vein, F. ac = Facial vein; Mand = Mandibular vein, Pt. Cav = Postcaval vein; H. P. = Hepatic Portal vein, R = Renal vein, A. Abd. = Anterior abdominal vein, R. P. = Renal portal vein: Pel = Pelvic vein, Sc. = Sciatic vein, Fe = Femoral vein, D. L = Dorso-lumber vein.

2. Hepatic Portal System.

Hepatic portal vein is formed by several other smaller veins which return blood from :

Stomach, Small intestines, Rectum, Pancreas, Spleen, together with anterior abdominal vein arising from the pelvic and cardiac vein from the heart itself produce the Hepatic portal system by producing extensive branching within the liver.

Q. 6. *Draw and describe the alimentary system of the Guinea-pig.*

Ans. The alimentary system of the guinea-pig is composed of the alimentary canal and the digestive glands.

Alimentary Canal :

1. *Mouth cavity or Buccal cavity.*
2. *Oesophagus or Gullet*
3. *Stomach or Gastrium.*
4. *Duodenum.*
5. *Small intestines*
6. *Large intestine consisting of*
    - (*a*) *Coecum,*
    - (*b*) *Colon,*
    - (*c*) *Rectum with its termination, i e., Anus.*

Digestive Glands :

1. *Liver or Heper,*
2. *Pancreas.*

Now let us describe them one after the other as stated above ,—

Mouth Cavity or Buccal Cavity .

The mouth cavity consists of a roof and floor and some contents.

Roof consists of the bony hard palate in front and fleshy soft palate behind.

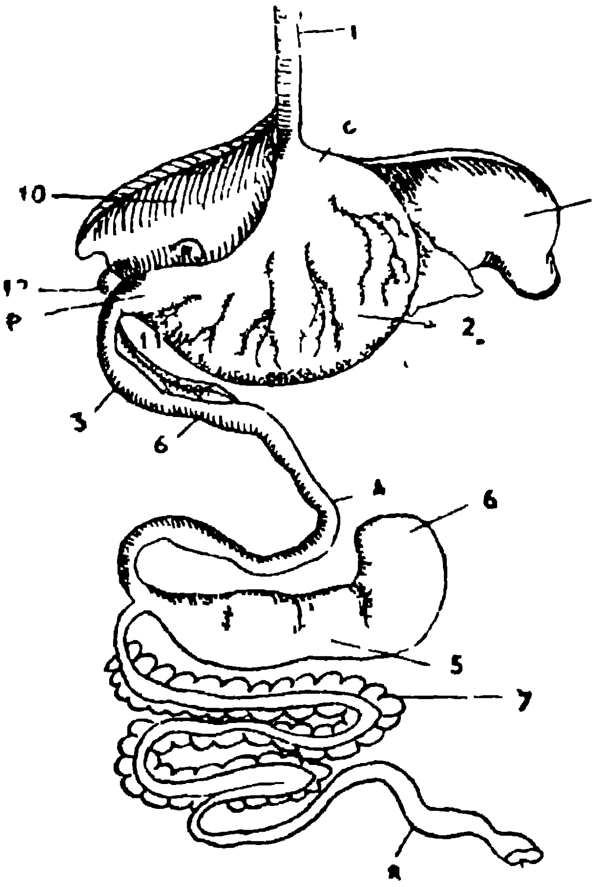
Floor. On the floor is the tongue which is fixed behind but free in front. It is covered with some white spots, called taste papillæ. Behind the organ is a big triangular patch containing a number of papillæ which are seen by means of a pocket lens.

Contents In front the jaws bear 20 teeth, 10 on each. The **dental** formulæ for each half of each jaw is $I\frac{1}{1}C\frac{0}{0}Pm\frac{1}{1}M\frac{3}{3}=10$. The teeth are lodged in sockets. The first pair of teeth known as **insisors** are chisel-shaped. The **canine** or the second **tooth** is absent. The gap thus formed in each half of the jaw is **called diastema**. The third type is one in number and is known **as Premolar**. The fourth type consists of three teeth **and are** known as **molar**. The insisors are used for cutting, **premolars** and molars for chewing and grinding The tongue rests **on the** floor. Two **tonsils** are seen, one on either side of the posterior part of the jaws and below the hindermost part of the soft palate No uvula is present in guinea-pig.

Salivary glands open into the mouth cavity by means of ducts. They are

(*a*) the infra-orbital glands lying in the cheek just **below** the eyes ,

(*b*) the sub-maxillary glands just inside the angle of the mandible



1 = Oesophagus or gullet ;
2 = Stomach .
C = Cardiac end of the stomach ;
P = Pyloric end of the stomach ,
3 = Duodenum ;
4 = Small intestines ,
5 = Cœcum ,
6 = Blunt end of the cœcum ,
7 = Colon ,
8 = Rectum ,
9 = Anus ;
10 = Liver ,
11 = Pancreas ,
12 = Gall bladder.

(*c*) the parotid glands lie between the external ear and the lower jaw ;

(*d*) Sub-lingual glands, on the inner side of the ramus of the lower jaw.

Behind the mouth cavity is the pharynx and is continous with it. Two eustachian tubes one from either side open into the posterior nasal chamber of the pharynx.

Behind the tongue and anterior to the pharynx is an opening called *glottis* To its anterior border is attached a thin cartilagenous flap called *Epiglottis.* Dorsally and behind this epiglottis is the opening of the **Oesophagus** It turns backwards along the neck

The Oesophagus during its course perforates the diaphragm and reaches the abdominal cavity. Here the *Stomach* begins

Stomach

It is a thin-walled sac continuous with the Oesophagus and pyriform in shape. The anterior end is called the **Cardiac end** and the posterior end is called the **Pyloric end** The stomach ends in a ring like constriction called the Pyloric constriction

Duodenum

After the pylorus, begin the portion of the **small intestine** called *Duodenum* This is the first part of the small intestine It is somewhat U-shaped tube held in position by mesentery and omentum

Next comes the second part of the small intestines called **Ileum** This consists of a few coils and ends in the large intestine

The large intestine has got three parts : the coecum, colon and rectum.

Coecum

It begins from the end of the small intestine It is a wide tube having a long wide blind end The vermiform appendix is absent.

Colon

The next portion of the intestine is called the **Colon** which goes to the right side of the animal and passes to the pelvic cavity where it is called **Rectum.**

Rectum .

The Rectum lies in the pelvic cavity. It is a straight tube ending in the **anus** which is the external (posterior) opening of the alimentary canal.

Liver

It is a very big gland in the body lying to the posterior surface of the disaphragm It consists of five-lobes and is of mottled colour. There is a bag of bile called **Gall-bladder** lying on the posterior surface of the liver between the 3rd and the 4th lobes The hepatic duct carrying bile from the liver gets into the gall-bladder and the **Cystic duct** from the gall-bladder unites with the **Panceatric duct** Thus they form a **common bile duct** and open into the beginning of the duodenum.

Prancreas

It is a lobulated gland extending from the duodenum to the left side of the abdominal cavity It has a duct of its own which joins the Cystic duct.

Q 7. *What are the facts on which theory of organic evolution is based ?*

Ans When discussed in the light of evolution we may think that any individual (plant or animal) of to day is the *child of the past* and also the *father of the future.*

By gradual modifications brought about either by circumstantial or environmental changes the present-day development has been reached

There are various grounds of strong evidences upon which the theory of evolution might be based

1. Structural

Both the internal and external structures of animals and plants when closely studied show a gradual complexity and inter-relationship within the parts of their bodies. In the animal kingdom we have protozoa which are unicellular. Hydra, though multicellular, has its body-wall composed of two layers of cells Similarly Leech or Earthworm has a three-layered body-wall and these layers give rise to tissues and different organs. Thus if we pass on to the craniata still more complications are seen. Though there are marked differences between an unicellular protozoon and multicellular metazoon, yet a close relationship between them is observed. As for instance some of the cells of the metazoa exhibit some structure as that of protozoa and still more they behave like protozoa The fore limbs of a toad, a reptile, a bird and a mammal are built on the same pentadactyle character. The skeleton of vertibrata are built in such a fashion that they definitely point out similarities The bones of the same region of different vertibrates are both homologous and analogous.

2. Embryological ·

If we trace the embryological development of several animals, we find that they agree in their earlier stages of development but gradually they show differences Thus because they agree in certain stages of development, we are convinced that they had a common origin, common forefathers but in course of time they have gradually differed from one another This view is known as recapitulation theory which states . *Ontogeny or development of individuals is the recapitulation of phylogeny or the development of race*

3 Physiological

These evidences are based upon experimental facts. When various types of dogs, cows, horses or birds are interbred, they give rise to new types In horticultural work many new forms may be seen arising. A sudden appearance of a new animal in the process of interbreeding may be obtained in many cases among the domesticated animals •

4. Geological

If the various strata and crusts of the earth be examined, the remains of the hard parts of the bodies of animals or plants or the casts of the same may be seen because these are kept preserved in these crusts.

Thorough and careful studies of these go to show the different gradations in the complications of the structures in the bodies of the biological units If we trace back the modern horse, the point is well-illustrated and convinced. Also the fossils at different depths of the strata of the earth give evidences of different groups of animals which correspond closely with gradual complexities according to the age.

5. Geographical :

If we compare either the plants or animals of different places, separated widely by expansive oceans or huge mountains, we see them of different types but if the origin be traced they give the same origin. But the plants or animals of the same place simulate each other. These differences or resemblances are due to the differences in the environment.

1938

FIRST PAPER

Q. 1. *Tabulate the main differences between plants and animals*

Ans. See Ans. to Q. 1 of 1935, Second Paper.

Q. 2. *Describe the different phases of indirect cell-division.*

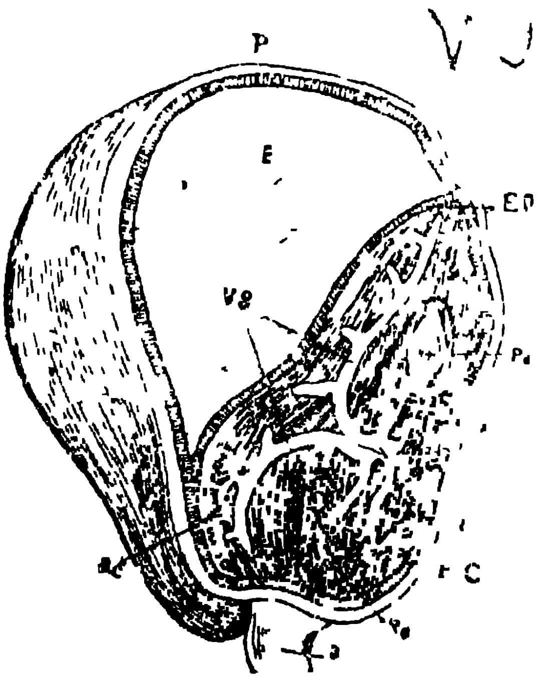
Ans. See Ans. to Q. 2 of 1936, First Paper.

N B.—Indirect cell-division is followed by indirect nuclear-division.

Q. 3 *Explain by means of a simple experiment the mode of respiration in a plant*

Ans. See Ans. to Q, 6 of 1936, First Paper.

Q 4. *Draw the section of a maize fruit and label the various parts.*



Ans A longitudinal section of a maize fruit is shown here and the various parts are labelled

P. = Pericarpal layer ,
A = Aleurone layer ;
E = Starchy endosperm ,
EP = Epithelial layer ,
Sc. = Scutellum ,
Ax = Axis ,
Pl = Plumule ,
R. = Radicle ,
R c. = Root cap ,
V.s. = Vascular strand-

Q. 5. *Describe the life-history of a fern.*

Ans. Specimen—*Dryopteris Filix-mas.*

The plant is commonly found growing on the rocks, **woods** and near the stream. This plant, during its life-cycle, **shows** two definitely different generations, the **vegetative body or sporophyte** and the **sexual body** or **gametophyte.**

Sporophyte :

The stem is a subterranean **Rhizome** whose apex **rises but** a little above the surface of the ground. From this **the aerial** leaves develop which remain curled like the tail of a dog **when** young This is called Circinate vernation. The leaves **are** composed of leaflets On the petioles are found brown **scales in** abundance, called **Ramenta**. The roots generally are **adventitious** and spring up from the basal part of the stem. The leaves are sometimes called **fronds.**

Early in the summer on the under-surface of the leaflets **by** the side of the mid-ribs and directly over the veins are **seen** greenish brown structures called **Sori.** Each sorus arises **from** the tissue of the leaf called **Placenta** The sori **bear stalked** sac like body called Sporangium, containing spores. The **sori** are protected by some placental out-growths called **Indusium.**

A fully formed sporangium is a capsule which has **a** specialised, cutinised cellular layer called **Annulus.** The annulus stops short in ce tain area and the cells of that part then form **a** structure called **Stomium.**

When a sporangium ripens, it dehisces through the **stomium** and spores are scattered on to the soil where each **germinates** ultimately into a heart shaped green thalloid body called **Prothallus** The spores are all similar.

From the narrow end of the prothallus which is directed towards the soil some brown thread-like structures develop **and** eventually reach the soil and act like roots. They are not **true** roots but **Rhizoids** The whole prothallus is of green **colour** and thus carbon assimilation goes on in it On its under **surface,** lower is the notch or base of the prothallus grow, on **a bed of** cushion the **Archegonia** and towards the apex grow **the Antheridia**

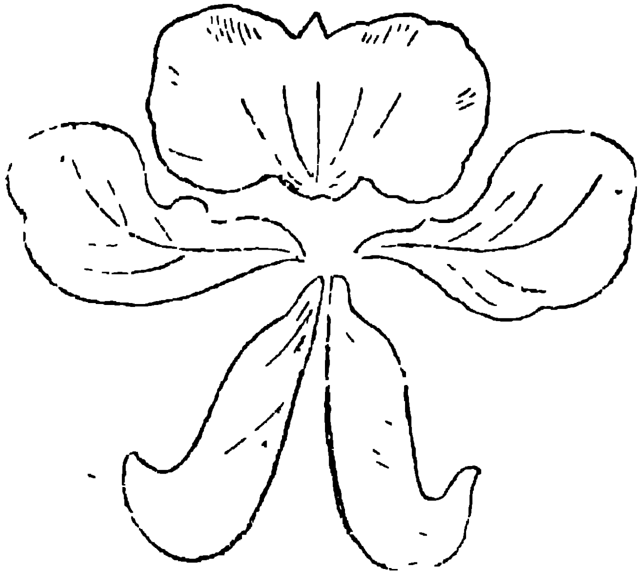
When both the archegonium and the antheridium **become** mature, the archegonium is divided into a ventre at the base and a long narrow neck above The ventre contains the oosphere or ovum. The antheridium gives rise to multicilliated antherozoids or spermatozoids

A canal-like passage is established through the neck of the archegonium and malic acid is secreted. Through this passage passes the antherozoid being attracted by the malic acid by the archigonium, and after reaching the ventre fuses with the oosphere and oospore is produced which soon secretes a cell-wall round it and next germinates into a new fern plant.

Q 6 *Draw and describe the various parts of a pea-flower*

Ans. *Diagram of all the parts of a pea flower.*

(See any Text-book)



Flower :—

Irregular, harmaphrodite, complete, pedicellate, perigynous, ebracteate, white or coloured.

1. **Calyx :** Green, sepals five and united, cup-shaped and bilobed.
2. **Corolla :** Petals—five, papilionaceous consisting of (1) a vexillum or standard, the biggest and the outer most petal (2) Two wings or alæ on two side and (3) a keel or karina, a boat-shaped structure formed of two petals lying opposite the standard. Aestivation Vexillary.

3. **Androecium** :—	Stamens 10 in two bundles (9+1), diadelphous, anthers dorsifixed.
4. **Gynoecium** :	Carpel 1 ovary superior, one-celled with many ovules on marginal placenta. Style bearded curved.

Q. 7. *Write short notes on any* **four** *of the following :—(a)* *'arasite, (b) Spike, (c) Conjugation, (d) Hypogeal, (e) Tendril,* *f) Pollination.*

Ans. (*a*) **Parasite :**

Parasites are organisms which live on and obtain their food aterials from the living plant or animal called the host. 'arasites are of two kinds :

(1) Total or Holo-parasites, such as *Swarnalata* which is ot green, and leafless and entirely depends on its host for utrition and draws its nutrient solution from the host by eans of special structure called Haustoria.

(2) Partial or Hemi-parasites. These derive a part of their od material from the host and the rest they themselves 'epare by their green leaves, *e g.*, Manda, Sandal.

(*b*) **Spike :**

It is a racemose type of inflorescence. Here the main axis elongated and grows indefinitely but the flowers are sessile. may be of two types :

(1) Simple, as in *Apang.*

(2) Compound, as in wheat. Here the rachis becomes anched and each branch bears spikelets.

(*c*) **Conjugation :**

See Ans. to Q. 7 (*a*), 1936, First Paper.

(*d*) **Hypogeal :**

During the germination of a seed if the cotyledon or cotyons remain buried into the soil and the plumule comes out in air by the activities of the epicotyl then the mode of germition is called Hypogeal ; such as in gram or date palm.

(*e*) **Tendril :**

This is generally the spring-like modification of stems, branches or even leaves or stipules specially meant for climbing a support ; as in Gourds, *Angur*, *Harjora*, etc.

(*f*) **Pollination** :

This is a process of transference of pollen grains to the proximity of the ovules. Thus when matured pollen grains from the anthers are carried to the stigma for the purpose of fertilization, the process is called Pollination

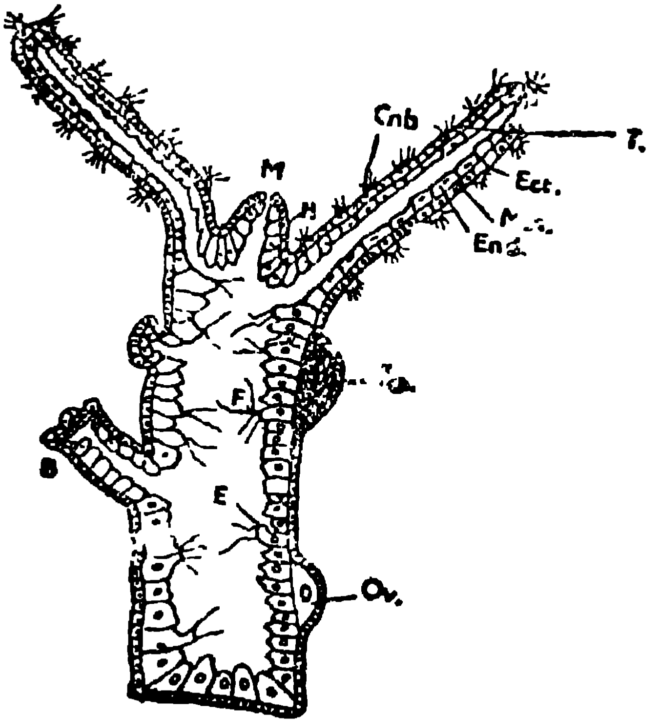
SECOND PAPER

Q 1 *Give an account of the methods of reproduction in Monocystis.*

Ans See Ans. to Q. 2, Second Paper, 1935.

Q 2 *Describe the external features of Hydra and show how takes its food*

Ans.



M = Mouth ,
H = Hypostome ,
Cnb. = Cnidoblast ,
T. = Tentacles ,
Ect -- Ectoderm ;
End. -- Endoderm ,
Mes = Mesoglea ,
Sp. = Spermary or teste
Ov. = Ovary ,
B. = Bud ;
F. = Flagella ,
E. = Enteron.

Hydra has a hollow cylindrical body. The cylinder is rather wider in the middle than near the ends. Its one end remains ixed to the water weeds and the other end free. At this free nd it has a number of (nearly 9) long fine **tentacles** On being rritated the body contracts and expands lengthwise. Its mouth s placed upon a conical projection called the **Hypostome** at its ree end. The fixed end is called the **Base** The cells of the asal region are peculiar in containing granules of the substance ecreted by the protoplasm which is used to fix the animal to he surface it hangs from.

The hollow cavity in the body of the hydra is the gut or **nteron**. Just below the tentacles lie the testes and the ovary ear the fixed end or the base of the body. Buds are often ound arising from the body.

When examined under a high power, the body is seen to be omposed of two layers of cells. The outer layer is called the **ctoderm** and the inner layer, the **Endoderm**. In between hese two layers is seen a structureless lamella called **Mesooea**, a gelatinous substance cementing the two layers. This mella comes out as the secretion of both the ectoderm and ndoderm.

Some special cells might be seen, in greater abundance owards the mouth-end and the tentacles, lodged superficially mong the ectodermal tissues projecting externally These are alled **Cnidoblastic cells**. Each of these cells has a triggerke process called **Cnidocil** at the side and a sac with a long hip-like structure within, called **Nematocyst**. The cnidoblasc cells are hollow and contain a fluid within their cavities. hese nematocysts are the weapons to capture the animals of rey. The hook like processes at the root are called **Barbs**. ydra takes its food in an interesting way. When a minute nimal happens to be in its front and touches its tentacles, ddenly the tentacles curve round the prey and the cnidocils esent there are pressed or affected chemically by the substans given out from the body of the animal and thus they are ritated. The irritation causes the contractile fibres of the idocils to squeeze the sacs. The pressure upon the contained uid, due to squeezing, expels the whip, turning them inside it The whips pierce the soft tissue of the prey Immediately e fluid from the Cnidoblast comes in contact with the prey hich becomes paralysed by the action of it. Gradually the-tentacles contract and the prey is thrown into the mouth, and is eventually swallowed.

Q. 3. *Describe the nervous system of Leech.*

Ans. The nervous system of leech consists of three parts,—

(*a*) The central nervous system, (*b*) the peripheral nervous system and (*c*) the sympathetic nervous system.

(*a*) The **central nervous system** consists of :

(1) A pair of **cerebral ganglia** lying on the dorsal side above the pharynx.

(2) A double nerve cord with twenty-one ganglia on it lies along the mid-ventral line and runs from the sub-pharyngeal ganglionic mass to the terminal ganglionic mass

(3) The anterior end of the double nerve-cord described above begins from a number of fused ganglia, generally four pairs, placed below the pharynx and oesophagus This mass of fused ganglia is called the **Sub pharyngeal ganglionic mass.**

(4) The cerebral ganglia are connected with the sub-pharyngeal ganglia by two connectives, one on either side looping the œsophagus These connectives are called **Peripharyngeal Connectives**

The **terminal ganglionic mass** is produced by the fusion of seven pairs of ganglia together

From the cerebral ganglia, the eyes and the front part of the leech are supplied and from the ventral ganglia, the rest of the body is innervated

(*b*) The **peripheral nervous system** consists of paired nerves given off from the various ganglia of the central nervous system From each paired ganglion of the ventral nerve-cord two pairs of nerves, the **anterior laterals** and the **posterior laterals** arise.

(*c*) The **Sympathetic nervous system** consists of an extensive nerve-plexus lying beneath the epidermis, within the muscle-layers of the body-wall and on the wall of alimentary canal

Q. 4 *Describe the vascular system of the fresh-water Prawn*

Ans The vascular system of the prawn (Palæmon) consists of (*a*) the heart, (*b*) the arteries and (*c*) the sinuses or blood lacunæ.

(*a*) **Heart**.

The heart is a triangular muscular organ, situated in the posterior part of the cephalothorax. It is placed within a thin-walled bag called the **Pericardial sinuses**. This, pericardium is nothing but a portion of the Hæmocoel, or body-cavity containing blood and possessing no epithelial lining

The heart is perforated by five pairs of apertures These are called **Ostea** The margins of the ostea are guarded by valves, so that the blood can enter the heart from the pericardium but cannot go to the pericardium from the heart The cavity of the heart is traversed by a large number of muscle fibres.

The distribution of the ostea is as below :—

(1) One pair is placed on the dorsal surface of the heart.

(2) The second pair is placed on the ventral surface.

(3) The third pair is situated at the posterior border of the base of the triangular organ These are placed on either side of the mid line

(4) The fourth pair of ostea is lateral in position and is situated anteriorly on the sides of the apex.

(5) The fifth pair is also lateral in position and is situated near the posterior on the lower or ventral surface of the lateral angles of the heart

The heart receives the blood from the pericardial sinus and pumps that out into the arteries by contractions.

(*b*) **The arteries :**

The following main arteries are given off from the heart :—

(A) *The arteries arising from the anterior region* :

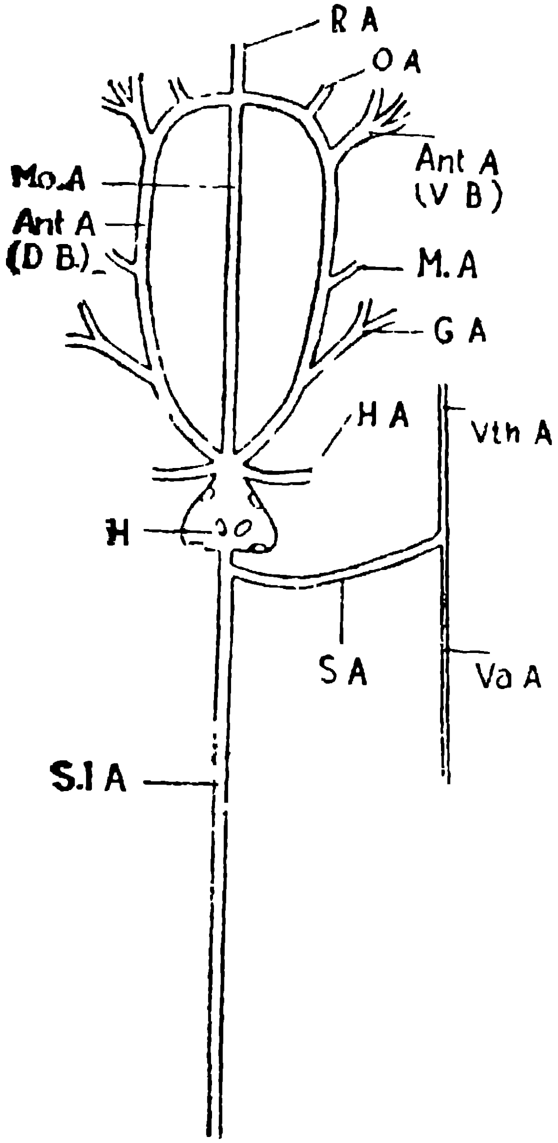
(1) The **median ophthalmic artery** which goes to supply the rostrum and the eyes.

(2) A pair of **antennary arteries**, just on the sides of the **ophthalmic** arteries, supply the antennæ and gives off branches **to the** mandible and stomach.

(3) A pair of **hepatic arteries**, supply the hepato-pancreas.

(B) *The arteries arising from posterior region* ·

(1) A **median artery** arising from the middle of the posterior ventral surface of the heart, passes for a little distance posteriorly and divides into—



[H.—Heart ; H A.—Hepatic artery , G. A.—Gastric artery ; M. A —Mandibular artery Ant A (D. B)—Antennary artery (Dorsal branch) , Ant. A. (V. B.)—Antennary artery (Ventral branch) ; Mo.A—Median ophthalmic artery ; O A. —Optic artery , R A.—Rostral artery , S I A —Supra intestinal artery ; S A. – Sternal artery ; Vth.A —Ventral thoracic artery ; Va. A.—Ventral abdominal artery]

(2) **Supra intestinal artery** which passes straight backwards above the intestine as far as the hind gut and supply blood to the intestine and the dorsal abdominal muscles.

(3) **Sternal artery** which passes straight downwards as a **branch** and after piercing the thoracic ganglionic mass comes to **lie on the** ventral side. It there divides into two branches :—

(*a*) **Ventral thoracic artery** which runs forward along the ventral region of the cephalothorax.

(*b*) **Ventral abdominal artery** which runs backwards along the ventral wall of the abdomen. All of these arteries form extensive branching within the body and finally open into the blood-lacunæ.

(*c*) **Blood-lacunæ** :

These spaces or sinuses are without proper walls and are situated among the muscles and Viscera These also form the body-cavity which differ from the cœlome by the absence of the epithelial lining and the presence of blood.

Due to the presence of blood these are called the **hoemocoel**.

Blood from the lacunæ passes into a pair of **ventral sinuses** placed on the ventral region of the cephalothorax These sinuses act as veins and from there blood passes to the gills through **afferent branchial channels** and is oxygenated there.

From the gills blood returns to the pericardial sinus through **efferent branchial** vessels.

Q 5. *Describe the mechanism of respiration in Bhetki.*

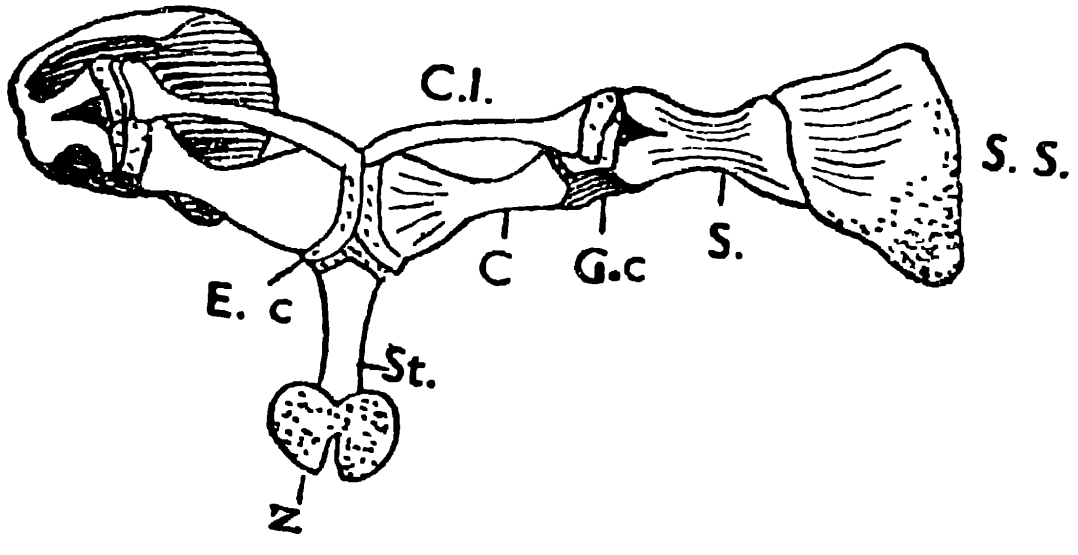
Ans. The mechanism is not much complicated. The blood s oxygenated in the gill-processes. This process of oxygenation s done by the suction of water through the mouth and passing he same into the pharynx. By the muscular mechanism, the yoid bone works and the pharynx alternately expands and ontracts.

The process of respiration consists in one of inspiration and he other of expiration. During inspiration the water enters hrough the mouth of the fish into the pharynx and now the outh and the opercula on both sides become shut up. The water now passes through the gill-processes and the oxygen that is dissolved in the water is taken up by the blood there. A thin membrane intervenes between the water and the blood. During this process of gaseous diffusion the carbon dioxide of the blood goes into solution with the water and thus the oxygenated water becomes poorer in oxygen but richer in CO_2. In this condition the water comes out during the processes of expiration. During this expiration the gill arches separate widely and the oesophagus also contracts The operculum on each side with the folds of mucus membrane gives a wide opening and the water comes out

There are valves of mucus membrane between the mouth and the pharnyx These prevent the oxygenated water going back into the mouth but lead through the pharynx.

Q. 6. *Draw a diagram of the pectoral girdle of a Toad and label the various parts.*

Ans.



Z.—Xiphisternum ,
S.—Scapula ,
S. S —Supra scapula ;

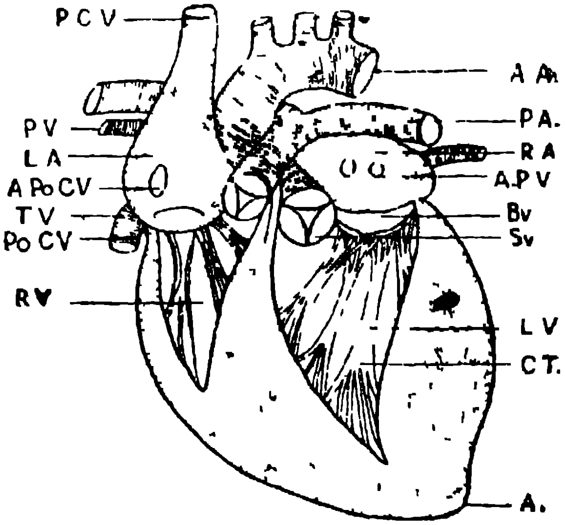
C —Coracoid ,

St.—Sternum ,
Ec. Epicoracoid ;
Cl —Clavicle.
Gc —Glenoid cavity.

Q. 7. *Draw and describe the internal structure of the heart of a Guinea-pig*

Ans. The heart of a guinea-pig consists of four chambers—two in the right and two in the left of the animal.

P C.V.—Pre caval vein ;
P.V – Pulmonary vein ,
A. Po. C V.—Aperture of the pestcaval vein ,
R.V.—Right ventricle ;
A.A —Arch of aorta ,
P.A.—Pulmonary artery ,
L.H.—Left auricle ,
A.P.V —Aperture of the pulmonary vein
B V.—Bicuspid valve ,
L.V —Left ventricle ,
C.T.—Chordae tendineae ,
A.—Apex.



Right

On the right side, the heart consists of two chambers : one anteriorly placed and the other posteriorly placed The anteriorly placed sac is called the right auricle and is made up of thin muscular wall It has three openings The first is for joining the **inferior vena cava** in the post-caval, the second for joining the common trunk formed by the superior venae cavae or pre-cavals and the third for joining the right ventricle.

The impure blood from the whole body is drained into the right auricle This *blood* next passes just into the right posterior chamber called the Right ventricle The opening of the auricle to the ventricle called the Auriculo-ventricular opening is guarded by three *semilunar valves* or *tricuspid valves* The free ends of these flaps project into the right ventricle and are connected by means of some muscular chords called *Chordae tendineae* These muscular chords are attached to some stouter pillar-like processes growing from the wall of the right ventricle These pillar-like processes are called *Collumnae carneae.* The right ventricle again has an opening, which is the beginning of the pulmonary artery which next divides into two and enter the two lungs where they ramify

This opening, *i e.*, the opening of the right ventricle to the pulmonary artery is guarded by three semilunar valves. During the contraction of the right ventricle the right auriculo-ventricular valves close and hence blood cannot regurgitate into the right auricle but is driven into the pulmonary area only.

Left :

The left auricle receives pure blood from pulmonary area by means of the pulmonary veins one from each lung This opening is not guarded by any valve The auricle consists of a sac of thin muscular wall The blood from this left auricle passes into the left ventricle. This opening is called the left auriculo-ventricular opening and is guarded by a valve of two flaps called the *Bicuspid valve* These flaps are connected to the ventricular wall by means of muscular columns The effective mechanism of this valve is similar to the right auriculo-ventricular valve. The muscular wall of the left ventricle which is placed posterior to the left auricle consists of a very thick musculature and drives the blood through the *aorta*, *i e.*, the first branch of the heart. This aortic opening is guarded by three semilunar valves called aortic valves which can open into the aorta and not into the ventricle Thus when the blood is once driven into the aorta by the left ventricle, the valves close and no blood returns into the ventricle.

1939

FIRST PAPER

Q 1. *Describe the main structures of a typical plant cell and mention its differences from an animal cell.*

Ans. See Ans. to Q. 1, First Paper, 1935 and Q. 1, Second Paper, 1937.

Q. 2. *Tabulate the main differences between respiration and carbon assimilation in plants.*

Ans The main differences are tabulated below :—

RESPIRATION	CARBON ASSIMILATION
1. CO_2 is given out.	1. CO_2 is obsorbed.
2. Oxygen is absorbed.	2. Oxygen is given out.
3. Protoplasm is broken down.	3. Protoplasm is generated.
4. It is a destructive process	4. It is a constructive process.
5. Energy is liberated.	5. Energy is absorbed.
6. No chlorophyll is necessary.	6. Chlorophyll is necessary.
7. It takes place in all living plants and living cells of plants.	7. It takes place only in green plants and in mesophyll cell.
8 It takes place always, day and night	8. It takes place in sunlight only
9. The plant loses in dry weight	9 The plant increases in dry weight
0. It is very vigorous in growing parts of plants.	10 Less vigorous in growing parts of plants.

Q 3. *What are the functions of roots ?*

Ans. The functions of roots may be divided into two main classes Some carry on the normal functions and others, special functions.

Normal functions :

(1) The first and foremost function of a root is to fix the plant upon the soil tightly and rigidly so that storm and wind cannot oust the plant from the soil Such a function is particularly carried on by the primary roots or the secondaries.

(2) The next function can be called the vital function of absorption The roots with the help of the root-hairs draw up or absorb the nutrient solution from the soil and transfer the

absorbed solution to the shoot. The hairs, called root-hairs are found just behind the tips, *i.e.*, behind the root-caps. The absorption of the nutrient solution from the soil is done by the process of osmosis.

Over and above these, functions called **special functions** are also carried on by specially adapted roots.

(3) In some forms of roots food-materials are kept reserved for future use of the plant Such roots act as storage for food. In *Mula* (Radish), Carrot, Beet, Dalhia, Sweet potato, etc, the swollen and succulent underground parts are the storage roots.

(4) Some plants climb up a support by means of their roots (adventitious) growing from the nodes of the stems and these act like climbing or clinging organs Such is found in Seindupsus (Gajpipul), pan and others.

(5) There is another class of roots called Prop-roots as in Banyan or Bat. They grow from the branches downwards and eventually they touch the ground and give support to the branches The stout roots arising obliquely from the lower parts of the trunk of the screwpine (*Keya*) give anchorage to the plant and are called still roots.

(6) Sometimes the roots might be modified into thorns as protecting organs Such types are seen in Sugarcanes

(7) In the parasitic plants some root-structures are pushed into the host plant to draw the nutrient solution from it and these are called Haustoria or sucking roots as in *Swarnalata* or *Manda.*

(8) There are some roots from which fresh shoots may grow, as in Patole, Water-Hyacinth These are called reproductive roots

(9) There are some breathing roots or pneumatophores. These are found in some marshy plants, such as Mangrove.

These grow upwards in air and bear some pores called Pneumatothodes on them. Through these the process of breathing goes on.

(10) Epiphytic roots or moisture-absorbing roots are found in Orchids. They are covered by a thin structure called velamen, through the agency of which they absorb moisture from the air.

(11) Assimilating roots are found in the Tinospora (*Gulan-ha*). These are thread-like structures hanging from big trees nd are green in colour. These can prepare carbohydrates from the air and water already absorbed by the plant.

(12) There are some inflated roots found in clusters in some quatic plants like water-hyacinth, kesardam, etc. These are alled Floating roots

Q 4. *Draw and describe a typical flower.*

Ans. For the First part of the Q , see Ans to Q. 3, First per, 1936.

A **typical flower** has four sets or whorls of floral leaves, ne being almost concentric to the other placed upon a ceptacle called Thalamus This type of flower is called a mplete flower.

The first two outer or lower whorls are non-essential organs nd the next two inner or upper whorls are essential organs.

Non-essential organs ·

(1) **Calyx**—This is the first or lowermost whorl This, in typical flower, consists of generally green **sepals** which are e in number and free

(2) **Corolla** – The next upper whorl is called the Corolla d it consists of five, free **petals** The petals might be riously coloured and alternate with sepals.

Essential parts .

(1) Next comes the third whorl This is called the **ndroecium** consisting of five or a multiple of five stamens hich are free.

(2) Now comes the uppermost or the topmost whorl. This the **gynæcium** or pistil It consists of one or more **carpels**. ach carpel has three parts The lowermost portion is called e **Ovary** which contains one or more ovules. The next upper read-like portion is called the **Style** and the top of the style called the **Stigma**. The ovary is superior and the flower is pogynous.

Q. 5. *What is alternation of generation ? Illustrate it from the life-history of moss.*

Ans. For the first portion of the Q. see Ans. to Q 5, First Paper, 1935.

For the 2nd part, see Ans. to Q. 6, First Paper, 1937.

Q. 6. *Describe briefly the life-history of Spirogyra.*

Ans. See Ans. to Q. 5, First Paper, 1936.

Q. 7. *Write short notes on any* **four** *of the following .—*

(*a*) *Epigeal,* (*b*) *Aggregate fruit,* (*c*) *Saprophyte,* (*d*) *Xylem,* (*e*) *Venation,* (*f*) *Hermaphrodite flower.*

Ans. (*a*) **Epigeal :**

During the germination of some seeds the cotyledons come out of the soil due to the elongation of the hypocotyl During the germination of gourd, tamarind or castor seed the cotyledons are carried up above the soil. Such sort of germination is called Epigeal.

(*b*) **Aggregate fruit :**

It is the matured multi-carpellary apocarpous pistil of a single flower after its fertilisation

Strictly speaking an aggregate fruit is that which appears like a single fruit, but really this single fruit is composed of many fruitlets each developed from an ovary. Thus this type of fruit is an aggregation of fruitlets scattered over the surface of a single receptacle It is called the False or Spurious fruit, *e g* , Custard apple, Rose.

(*c*) **Saprophyte**

There are some plants which do not possess chlorophyll and hence are not green. They, for their nutrition, depend upon some rotten, decaying organic matters. Saprophytes generally inhabit ill-illuminated places. Mucor, yeast and such other plants are all Saprophytes.

(*d*) **Xylem :**

Xylem is a part of the vascular tissue. Through it is **trans**orted the raw food materials from the place of **absorption to** he place of assimilation and also this tissue affords **mechanical** upport to the plant It is mainly made up of **tracheæ or** racheids accompanied by parenchyma and sclerenchyma. **The** valls are thick and generally lignified. This forms the **woody** art of a plant. Thus it is found in all woody plants. **The** arger vessels are called Metaxylems and the **smaller are** rotoxylems.

(*e*) **Venation :**

The vascular stands are also distributed in the leaf **lamina.** hey are called veins The mode of distribution and **arrange**ents of such veins in the lamina is known as venation.

(*f*) **Hermaphrodite flower :**

When a particular flower has both the androecium **and** ynoecium in it, the flower is called hermaphrodite or **bi-sexual.** *aba*-flower or *Pea*-flower is each a hermaphrodite flower.

SECOND PAPER

Q 1 *What do you know of the theory of* ***organic*** *olution ?*

Ans See Ans to Q 7, Second Paper, 1935.

Q. 2 *Describe the structure of an amœba ?*

Ans. See Ans to Q 2, Second Paper, 1936.

Q 3 *Draw and label the various parts of the* ***genital*** *stem of Leech*

Ans. See Ans to Q. 3, Second Paper, 1935.

Q 4. *Describe the alimentary system of Bhekti.*

Ans. See Ans to Q. 4, Second Paper, 1936.

Q 5. *Describe the course of circulation through the heart of Toad.*

Ans. To describe the course of circulation through the heart of a toad, a rough idea of the chambers of the heart and its accessories must be noted first.)

The heart is enclosed within a membraneous sac called the Pericardium Chiefly a toad's heart consists of three chambers The two auricles, left and right, placed anteriorly and one ventricle placed posteriorly On the dorsal aspect of these chambers is a triangular sac called Sinus venosus. It receives three main veins of the body, the two anterior and one posterior There is another stout tube-like structure called Truncus arteriosus arising from the right anterior side of the ventricle The opening of the ventricle to this truncus arteriosus is guarded by three semilunar flaps thus allowing the blood to flow from the ventricle to the conus or the swollen portion of the truncus only.

The truncus arteriosus divides into right and left truncus arteriosus and each of these divides again into three branches called Arterial arches These are as follows —

(1) Carotid arch, gives arteries to the head region.

(2) Systemic arch, gives arteries to the body.

(3) Pulmo-cutaneous arch, gives arteries to the lungs and skin

(4) The circulation of the blood is made by the pulsation or rhythmic contraction or systole and dilatation or diastole of the heart chambers, The sinus venosus contracts first and the contained blood, coming from the three principal veins of the body, passes into the right auricle The presence of the sino-auricular valves prevent the blood from going into the sinus again

(5) In the meantime the left auricle becomes filled up with the aerated or oxygenated blood brought to it by the pulmonary veins This blood flows towards the least resistant path. Thus the continuous flow of blood from the pulmonary vein prevents any regurgitation of the blood into the same In this way both the auricles become filled up with blood, one (right) with impure blood and the other (left) with pure blood.

(6) By this time the ventricle becomes empty and it dilates when the auriculo-ventricular valves are thrown open into the ventricle by the pressure exerted by the auricles during its contraction which now jointly begin to drive the blood from the auricles into the ventricle.

7) Now the ventricle becomes filled with the blood. The t portion contains the impure blood and the left portion es the pure aerated blood The middle portion however is l up with mixed blood. The spongy nature of the internal ricular wall retards the mixing of these two qualities of d. .

8) The ventricle next begins to contract gradually with ter force driving the blood into the conus.

a) When it first contracts, the venous blood from the right enters the pulmo-cutaneous arch being guided by the spiral e following the path of least resistance in its circuit through ungs. Thus the impure blood goes out of the ventricle and pening of the pulmo-cutaneous arch is closed by its valves.

b) As the ventricle continues to contract with a greater than before, the mixed blood from the middle portion of ventricle passes into the systemic arch. This blood cannot into the carotid arch owing to the great resistance offered he carotid gland.

c) Next the ventricle contracts with the greatest force and the pure blood from the left side of the ventricle passes the carotid arch overcoming the resistance offered by the tid gland or the carotid labyrinth.

hus the most part of the impure blood is seen to the skin pulmonary area to be oxygenated. The mixed blood is through the systemic arch to the trunk, limbs and viscera. pure and highly oxygenated blood however passes into the l and the brain owing to its being the centre of controlling ns of the animal.

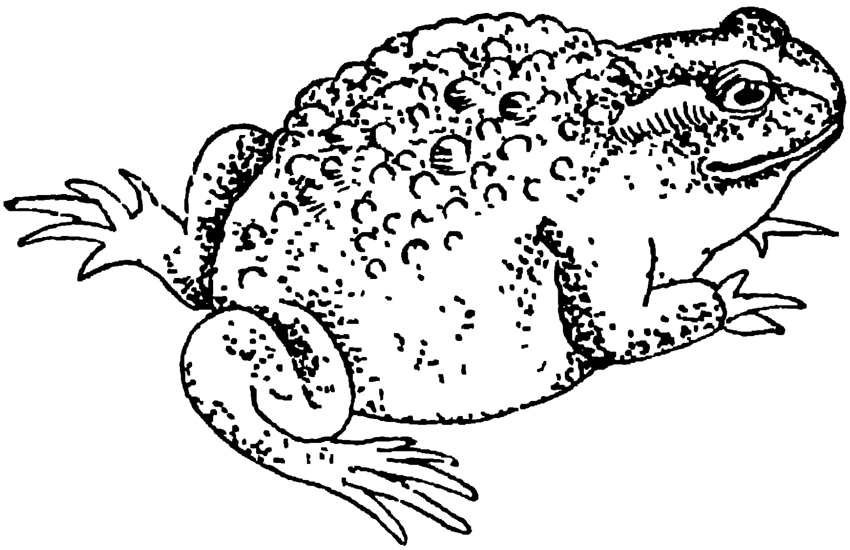
6 *Compare the external features of a Toad with that of a nea-pig.*

ns. When comparing the external features of a toad those of a guinea-pig, the following points should be idered .—

1) External characters in general ,
2) Description of the head with all its parts ,
3) The body ; and
(4) The limbs.

General external characters :

Of a Toad :



A.

(*a*) Peculiar squanting posture of the body

(*b*) At the anterior end is a big semi-circular slit, the mouth.

(*c*) No distinct neck.

(*d*) No external ear.

(*e*) No tail.

(*f*) A number of wart growths on the body

(*g*) No hair.

(*h*) Presence of paroti glands on the head

B.

Of a Guinea-pig

(*a*) Body horizontal and supported by two pairs of limbs.

(*b*) The mouth is anteriorly and slightly ventrally placed bounded by two lips—the upper one is cleft in the middle.

(c) Distinct neck connecting the body and the head.
(d) Distinct external ears
(e) No tail.
(f) No warty growths.
(g) The whole body is covered with hairs.
(h) No parotid glands on the head.

Head :

Of a Toad :

(a) The mouth is in front.
(b) Two nostrils above the mouth.
(c) Two eyes, one on each side on the top of the snout
(d) Each eye has 3 eye-lids. The lower one is rudimentary d the upper one is thick and movable. The third is markedly ving called nictitating membrane.
(e) Behind each eye is the tympanic membrane.
(f) No pinnæ and no external auditory meatus.
(g) Eyes are big and protruding

Of a Guinea-pig

(a) The mouth is in front and slightly ventrally
(b) Two nostrils above the mouth.
(c) One pair of whiskers or vibrissæ by the side of the stril.
(d) Two eyes—one on each side.
(e) Each eye has two eye-lids—both movable. No nictita- g membrane, only rudimentary on the inner corner of the eye.
(f) Two pinnæ or external ears, one on each side surround- the auditory meatus.
(g) The shape of the head is almost round.
(h) Eyes are not protruding.

unk :

Of a Toad :

(a) The body is flat.

(*b*) Posteriorly it has no separate anus and urogenit opening but a common cloacal aperture.

(*c*) No teats or mammary nipples.

Of a Guinea-pig :

(*a*) The body is cylindrical—divided into thorax ar abdomen.

(*b*) Abdomen has teats or mammary nipples on the ventr surface.

(*c*) Coccyx is prominent but no tail.

(*d*) The posterior external openings are two, one for th rectum, and the other for excretory and the genital systems all are separate.

Limbs :

Of a Toad ·

(*a*) Two pairs of limbs—a pair of fore limbs and a pa of hind limbs

(*b*) Each fore limb terminates into 4 digits with no na and the hind limbs terminate into 5 digits each without a nail. Digits are slightly webbed.

(*c*) When it is at rest, its hind limbs assume the sha of "Z".

Of a Guinea-pig

(*a*) Two pairs of limbs—fore and hind.

(*b*) Each fore limb terminates into 4 clawed digits, i. nails are present and each hind limb terminates into 3 clawe digits.

Q. 7. *Draw a diagram of the pelvic girdle of a Guinea-pig*

Ans. See Ans. to Q 6, Second Paper, 1935.

1940

FIRST PAPER

Q. 1. *Give brief account of the special characteristics of living objects and compare them with those of non-living objects*

Ans See Ans. to Q 1, First Paper, 1937, and Q. 1, Second Paper, 1936.

Q 2 *Describe the structure of a pea seed and the mode of its germination.*

Ans. See Ans. to Q. 2, First Paper, 1935.

Q. 3 *What are the characteristics of a root ? How is it distinguished from a shoot ?*

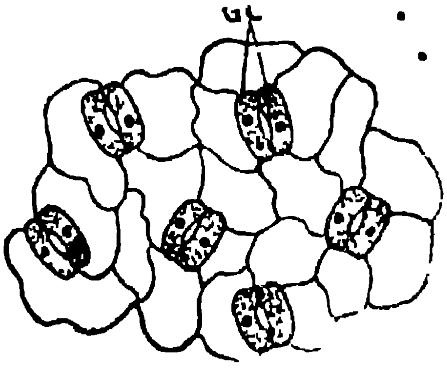
Ans. See Ans. to Q. 5, First Paper, 1937.

Q. 4. *What is the utility of a leaf to a plant ? What are Stomata ?*

Ans For the first part of the Q , see Ans. to Q. 3, First Paper, 1935.

Stomata :

The epidermal layer of leaves and young parts of stems are not continuous It bears some openings which are regulated by two kidney-shaped specialised cells These openings together with the cells are known as *stomata* (singular—stoma) The cells that regulate the opening are known as *Guard-cells.* Through these stomatal openings interchange of gases takes place from outside Just behind the openings into the tissue of the leaves, there are cavities, one for each. These cavities are known as *respiratory cavities.*



G C = Guard cell

These respiratory cavities in turn are communicated by loose cellular structures to the other tissues of leaves Thus through the stomata the internal tissues of plants are in connection with external air or atmosphere

Stomata are variously distributed in various types of plants. In a dorsiventral leaf, the stomata are scattered on the under surface and in aquatic plants these are scattered on the upper surface of the leaves , again in desert plants the stomata are sunken into the tissue of the leaves to avoid the exchange of *hot air* of the desert as far as possible Another type of stomata called **water stomata** are found in some aquatic plants These are larger than the ordinary stomata and their guard-cells do not contain protoplasm, hence cannot regulate the openings. Therefore, the pores always remain open through which water comes out in liquid condition.

Q. 5. *Compare a Pea Plant with a Maize Plant.*

Ans The following table shows the comparison of the two types of plants

PARTS	PEA PLANT	MAIZE PLANT
1. Type	Dicotyledonous plant	Monocotyledonous plant (Herb).
2. Root	True root, developing from radicle, branched afterwards having some nodular growths at the tip of the rootlets where some bacteria live symbiotically	True root ceases to grow soon Adventitious roots grow from the stem to keep the plant fixed There are no symbiotic bacteria
3. Stem	Solid, branched, climbing.	Solid, unbranched, erect.
4. Leaves	Compound, pinnately, with foliaceous stipules and part of the leaf or a few terminal leaflets are modified into tendrils Leaf-bases are swollen (pulvinus),	Leaves are simple distichous with sheathing base and ligulate. Broad and parallel veined

PARTS	PEA PLANT	MAIZE PLANT
Inflorescence	Recemose.	Compound spike.
Flowers	Complete, hermaphrodite, irregular, sepals—5,gamo- Petals—5, poly The posterior one is large, called vexilum or standard , 2 smaller lateral petals called alæ or wings The anterior one is boat-shaped and is called Carina or Keel,Stamens—10, in two bundles (9+1) called diadelphous. Anthers —dorsifixed.	Monœcious, *i e* , male and female flowers are developed on separate spikelets on the same plant Male flowers lie on the top and the female flowers, lower down the axis. **Male**—2 in each spikelet, one is sessible and the other is pedicelled Each flower possesses 4 glumes 1st and 2nd empty and flowery, 3rd and 4th paleate, hyaline and enclosed by the 1st one, Perianth 2, fleshy lodicules Stamens 3, slender filaments, versatile anthers.
	Carpel—1,ovary superior-one-celled but many seeded Style curved and stigma—feathery.	**Female**—2 in each spikelet protected by a pair of bracts called outer glumes Each floret has a pair of bracts—the outer flowering glumes and the inner of the palea. One floret from each is sterile. The fertile one is monocarpellary and has one-celled small superior ovary.
Fruit.	Legume or Pod.	Caryopsis.

Q. 6. *Describe briefly the life-history of mucor and show how it differs from that of a moss.*

Ans. See Ans. to Q. 6. First Paper, 1937, and Q. 6, First Paper, 1935.

Q. 7. *Write short notes on any* **five** *of the following* :—

(*a*) *Hypogeal germination*, (*b*) *phloem*, (*c*) *chlorophyll*, (*d*) *pollination*, (*e*) *stipules*, (*f*) *compound leaf*, (*g*) *parasite*, (*h*) *adventitious root*

Ans. (*a*) **Hypogeal germination** :

See Ans to Q 7(*d*), First Paper, 1938.

(*b*) **Phloem** ,

It is a vascular tissue commonly found in higher plants. It consists of sieve tubes, phloem parenchyma and companion-cells Sometimes however sclerenchymatous fibres may associate.

The functions of the phloem are to conduct prepared food materials from one part of the plant to another The seive tubes contain protoplasm and as such it differs from zylem. Thus it also displays some vital activities in addition to the mechanical function of transport.

(*c*) **Chlorophyll**

The chlorophylls are green colouring matter present in the green parts of plants in connection with the plastids of that region called chloroplastids This can develop only in sunlight and is essentially necessary for carbon assimilation or photosynthesis in plants. Chlorophyll contains iron.

(*d*) **Pollination**

See Ans to Q. 7(*f*). First Paper, 1938.

(*e*) **Stipules** ·

These are the lateral outgrowths of the leaf bases. Stipules are foliaceous in pea, free and latter in *Jaba*, spiny in acacia or *Babla*, etc.

(*f*) **Compound leaf** :

When a single leaf lamina becomes segmented into two or more leaflets with *distinct articulation* at the base of each leaflet and there being no bud at the axils of the leaflets, but such a bud develops at the axil of the complete compound leaf. In *Neem*, *Rose*, *Babla*, etc , we get compound leaves.

(*g*) **Parasites** ·

See Ans to Q. 7(*a*), First Paper, 1938.

(*h*) **Adventitious root :**

Adventitious roots are the false roots and do not develop from radicle but may develop from any other part of the plant. From the stems of banyan aerial roots develop so also from orchids, etc The climbing root of *Pan* is the example of an adventitious root The monocotyledonous plants soon after their germinations lose the true roots which are then replaced by the adventitious roots.

SECOND PAPER

Q 1. *Describe the essential structures of an animal cell.*

Ans. See Ans. to Q 1, Second Paper, 1937

Q 2. *Describe the method of movements (locomotion) of Amœba, Hydra and Leech.*

Ans.

Amœba : An amœba moves by the streaming movement of its protoplasm, *i e* , it always changes its body-form during the vegetative life by protruding pseudopodia or false feet. First of all the ectoplasmic layer is protruded in a certain direction and immediately the endoplasm is thrown or poured into it. It may protrude similar pseudopodium in another direction or in the same direction and thus the whole animal creeps from place to place. Amœba can also swim freely in the water.

Following types of movements are observed in **hydra** :—

(1) **Movement by contractions and expansions** :

The epithelo-muscular cells of the ectodern contract first and make the body shorter and wider. Next the endodermal cells contract to make the body longer and narrower This type of movement may be either voluntary for searching its surrounding for food , or involuntary, due to some sort of irritation.

(2) **Looping movement** :

The animal expands its body first and then bends that to fix the tentacles upon the surface Afterwards the body contracts and withdraws the basal part of the body, which it again fixes near the tentacles. The body is stretched and the process is repeated. Thus the animal exhibits movements like a caterpiller.

(3) **Somersault movement** ·

The animal stretches its body and, after bending that, places the tentacles upon the surface, then withdraws the basal disc, and holds itself in a vertical position with the tentacles facing downwards. Next the body is bent in the opposite direction and after attaching the basal disc upon the ground the animal again comes into vertical position with the tentacles facing upwards The process , is repeated and the animal exhibits somersault movement like the clowns of the circus

(4) **Creeping movement**

The animal sometimes holds itself in vertical position with the tentacles facing downwards and crawls on the tentacles by their contractions and expansion, which effect forward movement

(5) **Amœboid movement** ·

The animal protrudes pseudopodia from the cells of the basal disc and by their activities can change the place.

Leech : It moves by alternately fixing and loosening its oral and posterior suckers. Thus the body may extend or contract by the action of the body muscles A leech is also seen to swim about in water here and there on slight provocation. The muscular contraction and relaxation in leech are almost similar to those in hydra but the actual modes of movement differ.

Q. 3. *Describe the vascular system of the freshwater Prawn (Palaemon).*

Ans. See Ans. to Q. 4, Second Paper, 1938

Q. 4. *Write a brief account of the life-history of a Toad.*

Ans. The whole life-history of a toad is generally divided into three stages ·

(1) *Laying of eggs and their fertilization*
(2) *Larval or true tadpole stage*
(3) *Toad stage*

1. First Stage : Eggs, called spawns are laid down in large masses within gelatinous capsule by the side of a pond or any stagnant water Each egg separates from the other by a layer of gelatinous substance which not only keeps the eggs discrete but also prevents from being eaten away by birds or other animals. Next process of fertilization takes place by spermatozoa. Each spermatozoon fertilizes each ovum by penetrating through the gelatinous membrane of the ovum. Some time passes after this process when each brings forth a larva, called Tadpole. Each tadpole has a **big head** trunk and a small tail The body is uniformly dark in colour. *No limbs are seen at this stage.*

The eyes are situated on the dorsal side of the head. A little in front of the eyes, a pair of depressions, the nasal pits. are found.

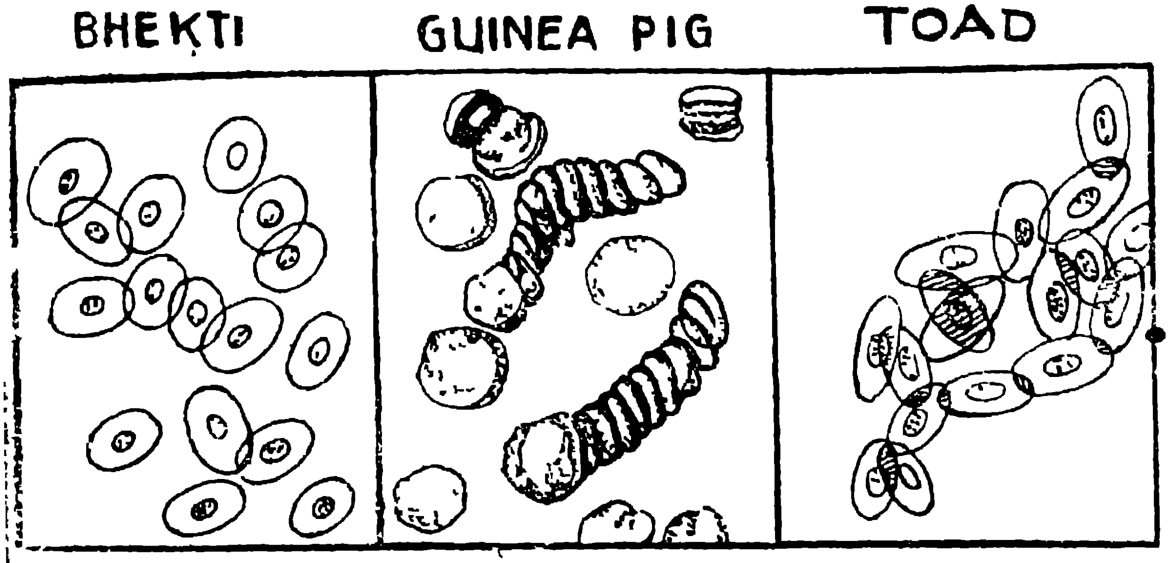
There is a cloacal opening but no distinct mouth except a small dimple in its place On the under surface of the head there is a glandular crescent called sucker secreting a sticky substance which helps the tadpole in keeping itself attached to an aquatic weed. Soon the gill-buds appear on each side of the head. These buds begin to grow more distinct and each of them is divided into three, the first one being the largest of the three. These act as breathing organs. Gradually a true mouth appears on the dimple which ultimately opens into the gut. The gut also rapidly grows and becomes coiled like the spring of a watch which can be seen with naked eye through the thin ventral abdominal wall. When the mouth opens, the tadpole feeds on aquatic plants and becomes more active About this time four gill clefts open from the pharynx to the outside.

2 **Second Stage** : This stage is practically the proper or true tadpole stage A fold of skin appears just at the roots of the external gills, one on each side. These gradually cover the gills that have developed on the branchial arches Each of these opercula grows One single aperture called branchial aperture on the left side however remains open. Through this only water passes out. Next the mouth becomes harder, and the lips appear.

3 **Third Stage** : This stage can be called the stage of clearer differentiation The appearance of the limbs of the animal is seen. The hind limbs are seen earliest and first. The fore limbs remain covered under the operculum. The lungs begin to develop from the Oesophagus The activity of the animal becomes less brisk and it fasts for some time, deriving its nutrition by absorbing its own tail which gradually begins to atrophy. The gills also disappear and the left branchial aperture becomes ultimately closed. The eye which had been so long under the skin becomes noticeable. The fore limbs appear and the animal emerges to the land as tailed toad. Now the animal becomes more and more hungry as the tail is gradually absorbed. It becomes a carnivorous animal, feeding upon animalcules or even it sometimes devours its fellows. Thus a grown-up toad develops and breathes air and finally becomes a terrestrial animal This type of change of form which occurs during the life-history of an animal is called Metamorphosis.

Q. 5. *Draw and describe the red blood corpuscles of Bhekti, Toad, and Guinea-pig.*

Ans. The red blood corpuscles of mammals differ from those of fish and toad in various respects. The red cell of mammalian blood is considered to be a fluid droplet contained within a delicate, colourless and elastic membrane, a solution of hæmoglobin along with other substances which remain in perfect solution. The red cells of toad and fish resemble in colour but differ in size and other structures Mammalian red cells are of smaller size whereas the red cells of toad and fish are of larger size.



The distinction can be well made out from the following table :—

BHEKTI	TOAD	GUINEA-PIG
Red in colour.	Red in colour.	Red in colour
Bigger in size	Bigger in size	Smaller in size.
Nucleated and oval with a slight tendency to become oval.	Nucleated and oval.	Non-nucleated and spherical.
Bi-convex in shape	Bi-convex in shape	Bi-concave in shape

N B —In the early stages of development the red cells of a inea-pig show the nucleated structures but after full develop- ent each of them becomes non nucleated

Q 6. *Describe the formation of the three germinal layers in llus (fowl).*

Ans. The male and female sex-cells known as **gametes** ite to form the **zygote**, hence the fertilised **hen's egg** or **zygote**

is a double structure composed of both male and female nucleu and protoplasm.

The process by which the non-cellular zygote divides int cells is called **Cleavage.**

The first few generations of cells produce by cleavages are called **Blastomeres**. The cytoplasm of hen's egg is much extended and contains a lens-shaped area known as **germinal disc**—it gives rise to the greater part of the bird. The early cleavage is restricted to this area. This is due to the greater mass of yolk which prevents the formation of cells except over this area Thus the division of the hen's egg is called partial or **Meroblastic.**

The first step in the process of cleavage is the appearance of the two vertical furrows at right angles to one another. Four radical furrows then appear about midway between the former furrows All these furrows are superficial, *i e*, only penetrate the surface of the germinal disc but rarely extend to the bottom of the cytoplasmic disc.

By these processes the surface of the disc is converted into a mosaic small polygonal area bounded around by larger irregular divisions. The disc in this condition is called **Blastoderm**.

Section of the blastoderm shows that the disc of cells is not uniform in structure. It consists of several layers. Among these a cavity, blastocœl is formed by the accumulation of fluid. As the disc expands, the cells above are thinned out to form an outer germinal layer, the **Ectoderm** or **Epiblast**, and lower germinal layer, the **Endoderm** or **Hypoblast** The cavity below the hypoblast is called the **Sub-germinal cavity**, and corresponds to the archenteron of the fowl.

Shortly after the beginning of incubation an opaque band somewhat elongated in appearance, develops in the posterio part of the area pellucida.

This is called **Primitive streak** It grows rapidly backward and the pellucid area elongates simultaneously, so that th primitive streak always lies entirely in this area. This area du to elongation assumes pear-shaped outline.

As the primitive streak elongates, a fine transparent line is found running down its centre. The line afterwards produces a groove called **Primitive groove**.

The primitive streak is formed by the proliferation of the epiblast and the hypoblast cells but have little or no share in its formation Several cells bud off from the epiblast and migrate into the spaces between the epiblast and hypoblast as a paired sheet of loose tissue. This tissue is mesoderm or mesoblast.

The **epiblast** gives rise to the following organs and tissues of the chick :—(1) the epidermis and its appendages *i.e.*, tail, feathers, etc , (2) the nervous system, (3) the sense organs, and (4) the lining of the mouth and cloaca.

The **hypoblast** gives rise to the epithelium of the alimentary canal and the glands that spring from it.

The **mesoblast** gives rise to all the connective tissues, vascular, muscular and skeletal structures as well as to urinary and reproductive organs

Q. 7. *Write short notes on any* **five** *of the following :—*

(*a*) *Contractile Vacuole,* (*b*) *Alternation of Generations,*) *Botryoidal Tissue,* (*d*) *Statocyst,* (*e*) *Notocord,* (*f*) *Retina,* g) *Uro-style,* (*h*) *Diastema*

Ans (*a*) **Contractile Vacuole** :—It is a water-containing pace within the body of amœba and some other protozoa. It rves as excretory vacuole or excretory organ which always ndergoes expansion and contraction. It appears in the ectolasm as a clear space, generally spherical in shape, enlarging by he accumulation of waste gases, generally nitrogenous, and ursting suddenly by the contraction of the surrounding protolasm and disappears for the time being. It is again found at he same spot repeating the same functions. This must be ifferentiated from *food vacuole* which contains the ingested article. In amœba both forms of vacuoles occur. The conractile vacuole also serves as the respiratory organ.

(*b*) **Alternation of Generations** :—In a plant life two differnt stages are observed, one alternating with the other. One ge known as the **asexual stage** and the other is called the **ual stage**. When a plant or animal completes a full lifele it passes through these two stages. In the next, it again repeats in succession these two stages. The obelia specus, an animal similar to hydra, beginning from the embryo and up to the formation of the umbrella-like structures called Medusæ on the buds exhibits asexual generation. The medusæ when fully grown separate from the bud and swim freely in the water and soon sex-cells are developed on them which are liberated on the water and then the male cells fertilize the female cells. Thus the embryos are produced. The obelia and bud represent asexual stage, the medusæ and sex-cells represent sexual stage This sort of alternation from asexual to sexual or *vice versa* is known as alternation of generations

(c) **Botryoidal Tissue** : – This peculiar type of tissue is the characteristic of a leech and is composed of branched canals, the walls of which are formed of large cells loaded with black pigments This system of canals is in communication on the one hand with the blood-vascular system and on the other with the greatly reduced cœlome

(*d*) **Statocyst** · This is the balancing apparatus found in prawn and some other animals It lies partly in the distal part of the 1st segment and partly in the proximal part of the 2nd segment of each of the first antenna in prawn.

(*e*) **Notochord** —In the phylum vertebrata or chordata this structure is always seen in some stage of its development The bodies of this class of animals are supported by an internal axis, *i e*, the notochord. This develops as an elastic solid rod formed as an outgrowth from the dorsal wall of the primitive gut of the embryo.

(*f*) **Retina** —Retina is found in the eye. This lies behind the eye-ball. It is the screen, highly traversed by nerve tissues and blood vessels The images that are formed by the lens of an eye-ball fall upon this screen, called retina, and next the sensation of vision are carried by the optic nerve which is the continuation of the retina. The region of the retina where the optic nerve enters is called the *blind spot* · here if an image is formed, the sensation of vision is not carried to the brain. Just near to this blind spot is a cup-shaped depression with elevated margin called *Macula lutea* or yellow spot. This is the most sensitive spot in the retina of the eye.

(*g*) **Urostyle** :—It is the posterior bony continuation of the ertebral column of toad. It is unsegmented and comparable ith the coccyx. It is supposed that urostyle is formed by the sion of several vertebræ Anteriorly it has a dorsal median dge enclosing a prolongation of the spinal cord, but this erve cord when traced posteriorly appears missing.

(*h*) **Diastema** .—In guinea-pig and allied animals, the nine teeth are absent and the gaps thus formed remain as ual for life There are four such gaps in the both jaws of a inea-pig. These gaps are called Diastema.

1941

FIRST PAPER

Q 1 *Describe briefly the physical and chemical properties rotoplasm.*

Ans. See Q, 1, First Paper, 1936.

Q 2 *Describe the different phases of indirect cell-division.*

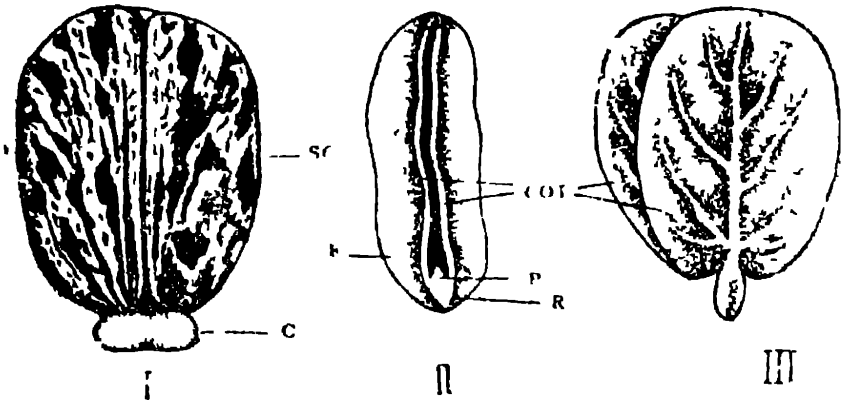
Ans See Q 2, first portion. First Paper, 1936.

Q. 3. *Describe and compare the structures of an albuminous l with that of an exalbuminous one.*

Ans. Castor seed and common **bean seed** are here the resentative types of an **albuminous** and **exalbuminous** kinds eeds respectively.

An external observation reveals that at the micropylar end astor seed an outgrowth developed from the seed-coat and ed **Caruncle,** forms a mass of spongy tissue. In common d instead of this a large scar called **Hilum** is present.

In castor seed **the coteledons are thin** and **leafy.** Surrounding **the** embryo and cotyledons is the massive **endosperm.**



Structure of castor seed

I—Seed with testa ; II—Seed after removing the testa ; III—Cotyledons.

Sc.—Seed coat or testa , C.—Caruncle , E.—Endosperm ;
Cot.—Cotyledons , P.—Plumule , R.—Radicle

In common bean seed the **cotyledons** are **thick** and **fleshy.** No endospermic tissue is found This endospermic tissue contains food In castor seed, which is endospermic or albuminous **the kernel** always consists of embryo and endosperm but in the bean seed which is non-endospermic or exalbuminous, the **kernel** represents embryo only.

Q. 4. *What are the principal functions of the shoot ?*

Ans. The following are the functions of the shoot :—

(1) Shoots carry on the process of intake or absorption o gaseous food materials from their surroundings. They absorl carbon dioxide from air or water, in submerged aquatics, anc assimilate it with the help of chlorophylls in presence of sun light and thus converting it into starch by the process of Photo synthesis. Other products are also formed in the shoots.

(2) From the shoots, again, the prepared food materials ar transported to the different parts of the plants either for bein stored up or being utilised.

(3) Sometimes foods when prepared and manufactured, are kept stored up in the leaves and branches. In Aloe (ঘৃতকুমারী), leaves contain prepared food materials.

(4) Shoots have the function to keep the plant machinery in healthy condition and, as such, they often get rid of the waste materials produced during metabolism. By transpiration shoots ged rid of surplus water and by respiration they get rid of carbon dioxide, water vapour and other waste gases and also take in oxygen for oxidation in the plant.

(5) Shoots bear branches, foliage leaves, buds and also reproductive organs or special shoots for the purpose, *e.g.*, flowers.

(6) Shoots have got to respond in accordance to the stimulus. They move towards light but they move away from the earth Thus they exhibit positive heliotropic and negative geotropic movements.

(7) Shoots themselves help the propagation of its own race by increasing new individuals In Marigold (গাঁদা) a branch when planted into soil develops into a new individual.

(8) Shoots help in the conduction of raw nutrient solution in different parts.

(9) Shoots, by growing themselves, help the plants to grow.

Q 5. *What are the functions of the leaf ? Distinguish between a simple leaf and a compound leaf.*

Ans. For the First Part see ans. to Q 3, First Paper, 1935.

SIMPLE LEAF		COMPOUND LEAF
A simple leaf is one in which the margins may be entire or incised in different ways but still it presents a single appearance.	1.	A compound leaf is one in which the lamina is completely incised into two or more leaflets each resembling a small leaf
A simple leaf possesses bud at the axil of the leaf.	2.	A compound leaf never possesses a bud at the axil of the rachis.

SIMPLE LEAF	COMPOUND LEAF
3. A simple leaf bears stipules, if any, at its base.	3 Leaflets of a compound leaf never bear stipules at their bases
4. A branch bearing simple leaves bears a terminal bud.	4. The rachis bearing leaflets never bears any terminal bud
5. The simple leaves of a branch are always arranged in an acropetal order	5. The leaflets of a compound leaf are not arranged in acropetal order.

Q 6 *Draw the different parts of a flower of pea and mention their functions*

Ans See ans to Q 6, First Paper, 1937, and also see ans. to Q. 5, First Paper, 1940

Fnnctions

(1) The calyx serves the purpose of protection of the bud.

(2) Corolla attracts bees from a distance that come in quest of honey there and polinate the Gynœciums.

(3) Andrœcium produces pollen grains.

(4) Gynœcium contains ovule and produces seeds after fertilization.

Q. 7 *Describe the prothallus of a fern. What phase does it represent in the 'life history of the plant'* ?

Ans Spores when ripe fall away from the fern plant on to the soil. Here the spore germinates into a green heart-shaped structure called the Prothallus. It is an independent self-supporting plant consisting usually of a heart-shaped plate not more than a quarter of an inch in diameter. The notch of the heart between the two lobes is deep. From its under-surface develop some unicellular thread-like structures called Rhizoids which eventually penetrate the ground and act as roots. It can assimilate carbon from CO_2 and also draws nutrient solutio from the soil.

The sexual organs, male called, **antheridia** and female called **archigonia** also develop on the lower surface of the same prothallus. The plant therefore is hermaphrodite. The antheridia produce, when mature, spirally-coiled multiciliated **antherozoids** or the male gamete units.

Just above the antheridia jug-shaped archigonia are developed. Each archigonium consists of a venter and a neck. The venter is immersed into the tissue of the prothallus. In each archigonium a female gamete or oosphere is developed.

When both the Antheridia and Archigonia become matured, the antherozoids are attracted by the archigonia and one antherozoid fertilises one oosphere The result of fertilization is the formation of an **oospore** which soon surrounds itself with a cell-wall After a time the oospore develops into a new fern plant which generally comes out through the notch of the prothallus

Thus we see that the prothallus of fern exhibits the gametophytic stage of the plant and is quite independent of the parent plant which exhibits the sporophytic generation.

SECOND PAPER

Q 1 *Tabulate the differences between the invertebrate and the vertebrate.*

Ans The animals possessing vertebral columns are called Vertebrates and those without it are called Invertebrates. Thus birds, reptiles, toads, etc are called Vertebrates. Earthworm, leech, prawn, etc are called Invertebrates These distinctions are not quite adequate. Though strict boundary lines are impossible to draw, yet some more important differences may be established in order to differentiate the two classes.

The following distinguishing points will help to clear the idea regarding the differences between the two classes :—

INVERTEBRATES	VERTEBRATES
1. No **notochord** or chorda dorsalis present in invertebrates.	1. **Notochord** or chorda dorsalis is the skeletal axis, growing dorsally to the primitive gut and this in higher Vertebrates are replaced by backbone.
2. In Invertebrates there is no distinct skeletal covering of nerve cord. If any nerve cord is present, it is **ventral** *e.g.*, in Prawn.	2. In Vertebrates generally distinct nerve cords with the skeletal covering is present. The brain and spinal cord is always **dorsal**.
3. No tubular channel or **neurocoel** is found passing through the central nervous system along its long axis	3 A tubular channel called **neurocoel** is found passing through the central nervous system.
4. No gill slits are found in Invertebrates.	4 Gill slits develop from the pharynx and open to the exterior In lower vertebrates they function as the organs of respiration but in higher Vertebrates they are functionless. They are seen in higher Vertebrates in embryonic life only.
5. Development of heart is not marked in Invertebrates. If seen, it is placed dorsally.	5. In Vertebrates heart is always seen and it is placed ventrally.
6. Body muscles are not metamerically segmented.	6. Body muscles are metamerically segmented.
7. Eye is developed generally from the skin.	7. Eye is developed from the brain.

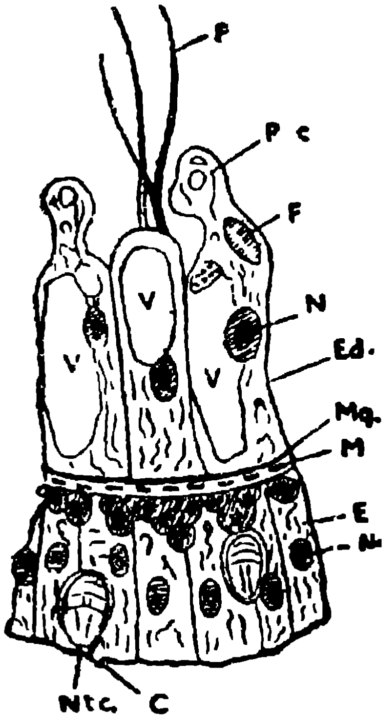
Q. 2. *Give the essential morphological characters and life-history of monocystis.*

Ans. See Q. 2, Second Paper, 1935.

Q. 3. *Describe the structure of the body-wall of* **hydra.**

Ans. The body-wall of hydra consists mainly of two-cellular layers having a central cavity or body-cavity called Cœlenteron. This cavity serves the function of both body-cavity and exteron.

P.—Flagella ;
P.C.—Pseudopodia ;
F —Food ,
N.—Nucleus ,
Ed. —Endoderm ;
V.—Vacuole ,
Mg. —Mesoglœa ,
M.—Epithelio-muscular cells ,
E —Ectoderm ,
C.—Cnidoblast ,
Ntc. —Nematocyst.



Of the two layers of the body-wall one is external, called **Ectoderm**, another internal, called **Endoderm.**

In between these two layers there is a cementing jelly-like layer called **Mesogloea**

1. The **ectoderm** consists of *three* kinds of cells :—

(a) **Epithelio-muscular cells** forming the main constituents of the layer These are conical-shaped, the bases turning to the exterior and the apex to the interior.

(b) **Cnidoblastic cells** form the second part of the layer oval in shape and lie in between the two successive epithilio-muscular cells. Each such cell is vesicular, and has a big nucleus and minute hair-like structure called *Cnidocil.* This appears to be homologous to the trigger of a gun. Within the cavity of the cell a long coiled whip-like structure called **Nematocyst** lies in retracted condition. This shoots out and paralyses he small animal which comes by chance near the hydra and presses the cnidocil accidentally Nematocysts are of three varieties,—long, short and spiral. The long one possesses barbs at the base. They are also called penetrant, volvent and glutinant, respectively.

(*c*) **Interstitial cells**—These are found as undifferentiated special cells filling the cavity in between the two successive epithelio-muscular cells These cells are precursor cells of new epithelio-muscular cells, nerve cells and cnidoblastic cells respectively

(*d*) **Nerve cells**—These are small star-shaped cells distributed throughout the ectoderm.

2. The **endodermic cells** forming the inner layer of the wall are larger in size and columnar in shape Each cell contains a nucleus, small amount of cytoplasm and a big vacuole. Some of the cells are provided with flagella and others with pseudopodia The endodermal cells along the body cavity function as digestive cells, a few towards the base function as glandular

3 The **mesogloea** is a jelly-like structure and acts to keep the ecto- and endo-dermic layers attached Some star-shaped cells are also seen here and there which are nerve cells

N B—In the tentacles the ecto- and endo-dermic cells are different from those forming the body-wall.

For Fig see Ans. to Q 2, Second Paper, 1938.

Q. 4 *Compare the modes of feeding of amœba, hydra and leech.*

Ans. Feeding of amœba—See Q. 2, Second Paper, 1936.

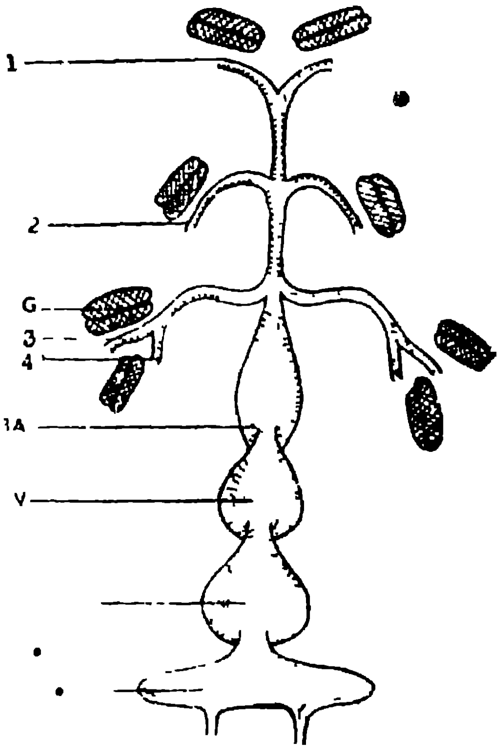
Feeding of hydra—See Q. 2, Second Paper, 1938.

Feeding of leech ·

A leech always feeds on blood of animals such as fish, frog, cattle, etc Sometimes however they catch on the bare legs of man or any other animal It catches its host first of all by its hind sucker and then it brings its muscular lips and protrudes the three chitinous teeth with which it presses on the spot. Since the teeth are like semi-circular saw, they cut out of a triangular area over the part and the animal begins to draw out blood. The blood thus drawn does not clot owing to the presence of a substance called hirudin. The animal sucks out the blood to fill up the eleven pairs of pockets of its crop, the terminal pair of which is the biggest. Now the animal appears swollen especially in its hinder part. This amount of blood it takes a long time, even a year, to digest.

Q. 5. *Describe the arterial or efferent branchial system of a Bhekti.*

Ans. Arterial system :



S.V. = Sinus venosus ,

A. = Auricle ;

V. = Ventricle ;

B A. = Bulbous arteriosus ;

G. = Gill

1 —4. = Afferent vessels.

In the fish the arterial system is distinguished as the (1) **afferent arteries** of the vessels, through which impure blood from the heart passes to the gills for purification and oxygenation. (2) **Efferent arteries** or **vessels**, which carry pure blood from the gills to the whole of the body.

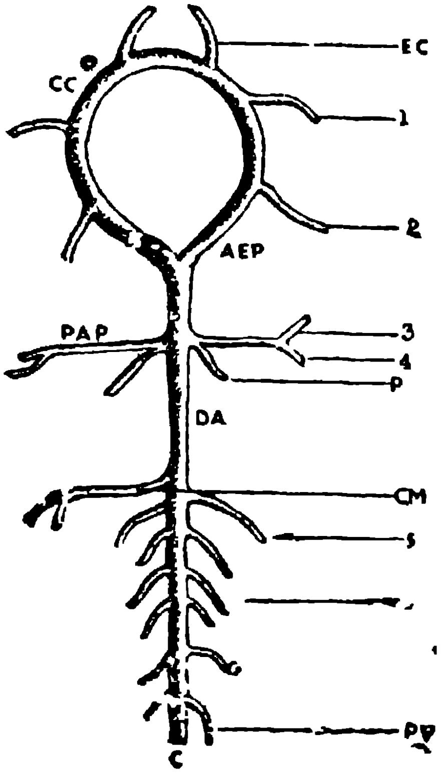
Afferent branchial arterial system :

From the **ventricle** a stout artery known as **ventral aorta** arises and passes forward to supply the gill arches with its branches. The ventral aorta is swollen at its base and that swollen portion is called **Bulbous arteriosus**.

The ventral aorta bifurcates, in the terminal part and forms the first pair of afferent vessels. It also gives two other lateral branches during the course. These are second and third pairs of the afferent vessels. From the third pair, the fourth pair arises. All these four pairs of afferent vessels supply the gills and break off into capillaries.

Efferent branchial arterial system :

Four pairs of **efferent branchial arteries** are found in the region dorsal to the afferent branchial vessels. Each pair of the efferent arteries corresponds to its respective pair of afferent arteries. These carry pure blood from the gills to the body for circulation. The first and second efferent vessels form a common **anterior epibranchial artery** on each side.



C. = Caudal artery ,
PV. = Pelvic artery ;
G. = Genital artery ;
R. = Renal artery ;
S. = Segmental artery ;
CM = Cœliaco-mesenteric artery ,
DA = Dorsal aorta ;
P. = Pectoral artery ;
PAP. = Posterior Epibranchial ,
AEP. = Anterior Epibranchial ;
CC = Circular artery ,
EC. = Carotid artery ,
1—4. = Efferent vessels.

The anterior epibranchials of both the sides unite to form the **dorsal aorta**. The third and fourth efferent vessels join to form the **posterior epibranchial artery** on each side which opens into the dorsal aorta.

In the anterior region the first pair of efferent vessels are connected to one another by a circular artery, the **circulous**

cephalicus, from which on each side, **internal carotid** artery to the brain and **external carotid artery** to the tongue, hyoid, etc. are given off. The dorsal aorta lies immediately below the vertebral column and gives off on each side, a **sub-clavian artery** supplying the pectoral fin.

The dorsal aorta, during its course, gives of a large **coeliaco-mesenteric artery** which divides into—

(*i*) **Coeliac artery**—supplying the stomach and liver.

(*ii*) **Mesenteric artery**—supplying the spleen and small intestines.

The dorsal aorta also gives off four to six pairs of **renal arteries** to the kidneys and two or three pairs of **genital arteries** to the gonads.

The dorsal aorta gives off several pairs of **segmental arteries** to the body muscles and a pair of **iliac arteries** to the pelvic fins. In the tail region the dorsal aorta passes through the hæmal canal and is called the **Caudal artery.**

Q. 6. *Draw the external features of a toad and label the various structures including the apertures.*

Ans See Q. 6, Second Paper, 1932 with the diagram there.

Q. 7 *Make a drawing of the alimentary system of a guinea-pig and label the parts.*

Ans. See Q. 6, Second Paper, 1937.

1942

FIRST PAPER

Q. 1. *What are the characteristics which distinguish the living from the non-living ?*

Ans. See Q. 1, Second Paper, 1936.

Q. 2. *Compare the modes of germination of pea-seed and maize-seed.*

Ans. For the mode of germination of a pea-seed see Q. 2, First Paper, 1935.

Germination of maize-seed :

The maize possesses one cotyledon only which serves exclusively as an absorbing organ and is known as the scutellum. It remains during the germination within the soil.

When a maize-seed is placed under proper conditions and environment, germination begins. First of all the radicle grows and next the plumule *grows hypogeally* The radicle breaks through the coleorhiza or root-sheath and then pierces the testa and the pericarp of the maize-seed and comes out First the radicle elongates and forms primary root with the root-cap at its end. Soon however this root ceases to grow and a number of adventitious fibrous roots come out from the hypocotyledonary region. The primary root soon dies. Next the plumule covered by the coleoptile grows up as a conical protuberance Soon the green leaf bearing shoot pierces the coleoptile and forms the aerial shoot but no branch is produced as in dicots.

Comparison

PEA-SEED	MAIZE-SEED
1. Germination is epigeal	1 Germination is hypogeal.
2. Hypocotyle elongates and this pushes up the plumule.	2. Plumule comes out after piercing the coleoptile or shoot-sheath.
3. The primary root continues to grow and other rootlets develop.	3 The primary root ceases to grow shortly and ultimately dies. A number of adventitious roots grow from the hypocotyledonary region.
4. Radicle does not pierce through the root-sheath as there is no root-sheath.	4. Radicle has got to pierce through the root-sheath called coleorhiza.

Q. 3. *Describe the various modifications of roots and stems for the storage of reserve food materials Give Indian examples.*

Ans. The modified roots that store up food for future use of the plants are generally the following :—

A. Modified tap-root :

(1) **Conical root**—Conical roots are underground cone-shaped, forms the broad base directed upwards from which a tuft of leaves grows in air and the *gradually tapering* end grows down into the soil, *e g*, in Carrot (গাজর) ।

(2) **Napiform roots**—Napiform roots are swollen above and suddenely tapering below, *e.g*, in Turnip (শালগম) ।

(3) **Fusiform roots**—Fusiform roots are longer in length but it is narrower above and below but swollen in the middle, *e g*, in Radish (মূলা) ।

B. Modified tap and branch roots :

Tuberous roots—Tuberous roots, as in sweet potato (রাঙ্গা আলু), are underground structures having tuberous appearance and brown rootlets are seen arising laterally. Other examples may be cited of Asparagus (শতমূলী), Dalhia.

The following types of stems also serve the purpose of storing food materials in them. They are mostly underground and some are aerial

(1) **Rhizome** : It is a modification of stem running horizontally in the ground. It produces shoots from the upper surface and roots from the lower surface. It has distinct nodes and internodes. It also bears buds and scales, *e g*. ginger family (আদা, হলুদ, আমআদা), etc.

(2) **Corm** : It is an underground stem round or oval in shape having buds on the sides and surfaces. These buds are young corms. This throws down roots from all over its surface. Scales are present on the upper region, *e g*., Ol (ওল) ।

(3) **Bulb** : This is another type of underground stem where the stem is transformed into an underground disc covered by scale leaves. Two varieties are seen : (*a*) Tunicated, as in onion (পেঁয়াজ), (*b*) Scaly, as in lily (সুখদর্শন) ।

(4) **Tuber** : It is oval or round in form and develops from both the tap and branch roots. It bears many scale leaves and buds throughout its body. These are known as eyes, *e g*., potato (আলু) ।

(5) **Aerial stem** : It is long unbranched aerial stem, cylindrical in shape marked by distinct nodes and internodes From the nodes come out the adventitious roots in whorls. The internodes are solid and full of sweet juice from which sugar is made, *e.g.*, Sugarcane (আখ) ।

Q. 4 *What are the functions of leaves ?*

Ans. Foliage leaves carry on various functions for the plant. These functions may conveniently be classified under two groups, one being (*i*) **Normal** and the other being (*ii*) **Abnormal**.

The normal functions are the following —

(1) Preparation of food materials by the process of photosynthesis, etc.

(2) Carrying on the function of transpiration.

(3) Process of respiration is mainly carried on from the surfaces of the leaves

(4) It serves as an organ for excretion

Abnormal functions :—

(1) Protection of buds.

(2) Bear buds or spores. Buds are developed from the margin as in Bryophyllum, and in Fern, the spores are borne on the under-surface of the leaves along both the sides of the mid-ribs.

(3) Sometimes leaves become succulent storing up food materials for the use of the plants for future needs or to cut down the process of transpiration as in aloe.

(4) Sometimes leaves are modified into spines as in cactus.

(5) Modification into climbing mechanism is also seen in some plants, *e g* , in pea, the upper pairs of leaflets of the compound leaf becoming transformed into tendrils to twine round a support.

(6) Leaves are sometimes adopted and modified for floating. In many water-plants such as Water Hyacinth, petioles of the leaves are swollen with air and thus float over water.

(7) Sometimes leaves are adapted to capture insects and to utilise them for food as in Nepenthes (pitcher plants), **Drosera** (sundew).

Q. 5 *Describe the different parts of a flower. What do you understand by complete and incomplete flowers ?*

Ans. *For First Part :* See Q 4, First Paper, 1939.

Second Part :

Generally a typical flower consists of (*a*) non-essential parts, and (b) essential parts.

The non-essential parts are calyx and corolla and the essential parts are androecium and gynaecium.

An incomplete flower is that which is devoid of any of the parts, whether the non-essential or the essential ones, as in Gastor, Gourd.

A complete flower, however, consists of both the parts, as in China rose.

Q. 6. *Describe the life-history of the Yeast plant.*

Ans. See Q. 7, First Paper, 1935.

Q. 7. *Write short notes on .—(a) Nucleus, (b) Osmosis, (c) Xylem, (d) Stomata, (e) Drupe.*

(*a*) **Nucleus :** It is the highly differentiated part of protoplasm which is the director and controller of all vital activities within the protoplasm and takes an important part in cell-formation and reproduction. It consists of nuclear membrane, chromatin net work, nucleoplasm and nucleolus.

(*b*) **Osmosis :** It is a physical process by which out of two homogenous liquids of different densities when separated by a semi-permeable membrane, the stronger liquid passes towards the weaker one until the latter reaches the same density by dilution.

(*c*) **Xylem :** It is the tracheal or woody tissue of a vascular bundle concerned with the conduction of raw food materials in solution from the soil. It is composed of four kinds of elements, *i.e* , trachæ, xylem, parenchyma and wood fibre.

(*d*) **Stomata :** These are minute openings in the epidermis of leaves and green stem , each is surrounded by two guard-cells and is meant for the interchange of gases and water vapour between the plant and the outer atmosphere.

(*e*) **Drupe :** It is a kind of fruit derived from a monocarpellary pistil with superior ovary as mango, jalpai, etc The pericarp differentiates into an outer exocarp, middle succulent mesocarp and inner hard endocarp forming stone within which generally one seed is present. In almond the mesocarp is dry and the endocarp contains two seeds. The coconut is developed from multicarpellary, syncarpous pistil and the mesocarp is fibrous there, hence coconut is called Fibrous drupe.

SECOND PAPER

[*Illustrate your answer with drawings as far as possible.*]

Q. 1. *Tabulate the difference between plants and animals.*

Ans. See Q. 8, First Paper, 1938.

Q. 2. *What do you know about the processes of locomotion, nutrition, respiration, excretion and reproduction in Amœba ?*

Ans. (*a*) *Locomotion*—See Q. 2, Second Paper, 1944.

(*b*) *Nutrition* —Pseudopodia are thrust out towards the particles of food, such as diatoms, particles of dead organic matter, minute green algae, etc., which become subsequuently engulfed within the ectoplasm and then it passes to the endoplasm and here the particles are surrounded by watery particles which constitute the food vacuole—the contents of which are first acidic and then alkaline.

(*c*) *Respiration*—There is no special organ of respiration.

The water in which the animal lives contains oxygen or air dissolved in it. This oxygen passes into the interior of the body by *diffusion.* Sometimes the contractile vacuoles serves as respiratory organs.

(*d*) *Excretion.*—This process is carried on from the body-surface of the animal, since there is no special organ, such as kidney or lungs, for the purpose. Further amount of excretion is also brought about by the bursting of big contractile vacuoles produced in the body These vacuoles gradually float up on the surface of the body from the endoplasm and burst there, giving out the waste products of metabolism.

(*e*) **Reproduction** .

The reproduction in amœba takes place in the following ways .—

Binary fission—Under favourable conditions, *i e.*, when oods are plenty, the animal reaches a full limit of development ithin a short period and divides by simple fission. This is ffected in the following ways . The nucleus becomes dumb-bell haped and the constriction in the middle becomes narrower. oon the nucleus separates into two halves and a constriction ppears in the cytoplasm. Gradually the two halves separate rom each other and two daughter amœbæ, each containing a ucleus, are formed.

Autogamy —This is a complicated process found in amœba oli. The individual divides into two and the nucleus of each aughter amœba throws a portion of it and then the daughter œbæ copulate.

Artificial reproduction—This can be induced by pinching the animal with the sharp pointed needle. The stimulus causes the animal to divide into two.

Multiple-fission or Sporulation.—During unfavourable conditions, the animal secretes a chitnous wall round its body and becomes encysted The nucleus breaks up into a number of daughter nuclei which travel towards the periphery and collect portions of cytoblasm round each of them. When favourable conditions come, the cyst wall breaks and a number of protoplasmic bodies, each containing a nucleus, comes out. These are called Spores. Each spore develops into a fresh amoeba.

Plastogamy —Sometimes a number of amœbæ fuse together and forms a mas of protoplasm with many neclei The mass is known as plasmodium and the process, plastogamy. The plasmodium separates into component parts after some time and the amœbæ thus produced use to carry on their lives independently. By thus temporary fusion they gain fresh vigour and are rejuvenated

Syngamy.—This is the process of the union between the male and female sex-cells and is very uncommon in amoeba. But in amœba Blattæ two sets of individuals are found, one smaller and the other larger and by their union a **Zygote** is formed. If these two sets be counted as male and female gamets then the amœba Blattae may be called **Syngamous.**

Q. 3. *Describe the urogenital system of Leech*

Ans. Urinary or Excretory System :

Nephridium is the unit of urinary system. There are seventeen pairs of such nephridia in a leech The first pair occurs i the seventh segment and one in each segment thereafter up t the 23rd segment. These open laterally on the ventral surface Each nephridium ends in a ciliated vesicle. Each nephridiu can be divided into two parts, one, the glandular region and th other spherical bladder which is lined internally with cilia.

Genital or Reproductive System :

See Q. 3, Second Paper, 1935.

Q. 4. *Draw the external features of Bhekti and label the various fins and apertures.*

Ans. See Q. 4, Second Paper, 1935.

Q. 5. *Describe the arterial system of Toad.*

Ans. See Q. 5, Second Paper, 1935.

Q. 6. *Compare the bones of fore limb with those of hind limb in a Guinea-pig*

Ans. See Q. 6, Second Paper, 1936.

Q 7 *Write notes on :—(a) Metazoa, (b) Statocyst, (e) Urostyle, (d) Retina, (e) Notochord.*

Ans. (*a*) **Metazoa** —The group of animals each of which consists of multicellular structure is called Metazoa. The cells of a metazoon are all interdependent in performing the functions of the biological unit. Hydra, leech, prawn or guinea-pig, each is an example of a metazoon.

(*b*) **Statocyst** : - See Q. 7, Second Paper, 1940.

(*c*) **Urostyle** —See Q. 7, Second Paper, 1940.

(*d*) **Retina** – See Q. 7, Second Paper, 1940.

(*e*) **Notochord** :—See Q. 7, Second Paper, 1940.

1943

FIRST PAPER

Q. 1. *What are the characteristics distinguishing the living from the non-living ?*

Ans. See Q. 1, First Paper, 1936.

Q. 2. *Describe the various changes a nucleus undergoes during the division of a vegetative cell.*

Ans. See Q. 2, First Paper, 5th Point, 1936.

Q. 3. *What do you understand by photosynthesis? Describe some experiment by which you can demonstrate it.*

Ans. See Q. 4, First Paper, 1935.

Q. 4. *Describe the Pea-flower and indicate the functions of its various parts.*

Ans. For the First Part, see Q. 9, First Paper, 1938, and for the Second Part, see Q. 6, First Paper, 1941.

Q 5. *Describe briefly the life-history of Mucor.*

Ans. See Q. 6, First Paper, 1935.

Q 6. *Describe the prothallus of a Fern. What phase does it represent in the life cycle of the fern?*

Ans. See Q 5, First Paper, 1938.

Q 7. *Write short notes on —(a) Chlorophyll, (b) Legume, (c) Mesophyll, (d) Polypetalous, (e) Periderm.*

Ans. (*a*) **Chlorophyll :**

These are generally green granules of a somewhat flattened ellipsoidal shape and are copiously found in parts of plants exposed to sunlight The green colouring of the parts of a plant is due to the presence of these corpuscles. These are essentially necessary in the process of photosynthesis or carbon assimilation.

(*b*) **Legume**

A legume or a pod, as it is called, is a dry monocarpellary fruit, derived from a superior ovary with one or more seeds. It dehisces by two sutures, one along the midrib (dorsal suture) and by another along the margins of the carpellary leaf (মটর শুঁটি) ।

(*c*) **Mesophyll :**

It is the green tissue of the leaf forming pallisade (columnar cells, packed closely) parenchyma and spongy (irregularly and loosely-packed star-shaped cells) parenchyma both bearing chlorophyll bodies.

(*d*) **Polypetalous :**

When the petals in a flower are all free and not joined or fused, the flower is said to be polypetalous, as in Jaba, Rose.

(e) **Periderm :**

During the circumferencial growth of a stem, the epidermis cannot keep pace with it. The soft moist tissue must be protected from excessive evaporation or injury. This is brought about by a newly-grown meristem, called Phellogen or Cork producer. This produces tissues both inside and outside. The outside tissue is impregnated with a bad conducting substance called Suberin. The inside cells that are produced are not suberised. This outer layer is called Cork and the inner layer, Phelloderm. All these three layers, suberised cork cells, phellogen and the phelloderm, are collectively known as Periderm. This happens during the secondary growth of a plant.

SECOND PAPER

[*Illustrate your answers as far as possible.*]

Q. 1. *Give some morphological evidences by which you can support the theory of organic evolution.*

Ans. See Q 7, Second Paper, 1936.

Q 2 *Compare the mechanism of feeding in Amœba, Hydra and Leech.*

Ans. See Q 4, Second Paper, 1941.

Q. 3. *Describe briefly the life-history of Monocystis.*

Ans. See Q. 1, Second Paper, 1935.

Q. 4. *Describe the various structures in the body-wall of Hydra and state their functions.*

Ans. See Q. 3, Second Paper, 1940, and Q. 3, Second Paper, 1941.

Q. 5. *Draw and label the various parts of the pectoral girdle of the Toad.*

Ans. See Q. 6, Second Paper, 1938.

Q. 6. *Describe the arterial system of the Guinea-pig.*

The main and the first artery arising from the heart of the Guinea-pig is the aorta. The base of the aorta is guarded by three semilunar valves. Just above the origin of the valves arise the coronary arteries which supply the heart.

The aortic trunk bends over to the left and passes backward below the spinal column and reaches near about the pelvis. Here it divides into two common iliac arteries which supply the hind legs and other parts.

For the sake of convenience the aorta is divided into the following —

(1) *Arch of aorta ,*
(2) *Thoracic aorta ;*
(3) *Abdominal aorta.*

1. The branches from the arch of aorta :

(*a*) Two small coronary arteries supplying the heart itself.
(*b*) Innominate artery dividing into—
  (1) Right subclavian ,
  (2) Right carotid ,
  (3) Left carotid.

The **Right subclavian** gives off the (*a*) **Vertebral artery** which passes through the foramina in the transverse process of the cervical vertebræ, (*b*) **Right internal mammary artery,** to the inner side of the ventral thoracic wall and distally it is continued to the fore limb as (*c*) **Brachial artery.**

The **Right carotid** passes along the neck by the side of the trachea and divides into **external** and **internal carotid** arteries. The left carotid similarly divides.

The **Left subclavian** is similar to the right subclavian.

2. Branches from thoracic aorta

The main arteries are the **intercostal arteries.** These supply the thoracic wall.

3. Branches from the abdominal aorta :

(*a*) **Cœliaco-mesenteric artery**—It is a single trunk dividing into two arteries :

(1) **Cœliac**—Supplying stomach, spleen, liver, and mensentives.

(2) **Anterior mesenteric**—Supplying the pancreas and small intestines.

(*b*) **Two renal arteries** supplying the kidneys on two sides.

(*c*) **Posterior mesenteric artery**—It is single, supplying the large intestines.

(*d*) **Spermatic or ovarian arteries**—Two in number, supplying the genital organs

(*e*) **Lumber arteries**—Supplying the posterior body-wall including the abdominal wall.

(*f*) The **abdominal aorta** is continued backwards as small **caudal artery**.

Each iliac artery divides into (1) **External iliac artery** which is further continued as femoral artery, and (2) **Internal iliac artery** This supplies the ventral abdominal wall and the pelvic cavity.

The **pulmonary artery** comes out of the ventricle and next divides into **right** and **left pulmonary** arteries. They supply the lungs.

Q 7. *Write short notes on any* **five** *of the following* .—

(*a*) *Metamorphosis*, (*b*) *Parthenogenesis*, (*c*) *Green gland*, (*d*) *Lateral line sense-organ*, (*e*) *Bidder's organ*, (*f*) *Cloaca*, (*g*) *Optic chiasma.*

(*a*) Metamorphosis :

It is a process in which a larva passes through several stages of development reaching at last the stage of its adult parent. In the metamorphosis of toad it generally passes through five stages.

(*b*) Parthenogenesis :

In this process ova produced by a female organism develop into an adult without being fertilised by male organism. Drones are produced in the beehive parthenogenetically. This phenomenon is also noticed in plants. Fern archigonia sometimes develop into a sporophytic stage without being fertilised by antheridia.

(c) **Green gland** :

Ans. See Q. 2, Second Paper, 1937.

(d) **Lateral line sense organ**

In many fishes and amphibians there are lateral line sense-organs. These are connected with gill-clefts. In Bhekti, there is one lateral line on either surface of the body running from behind the operculum and ending to the tail. By this line it feels the external stimuli.

(e) **Bidder's organ** :

In the male toad a small rudimentary ovary, known as Bidder's organ occurs at the anterior end of the testis.

(f) **Cloaca** :

It is a common chamber, as in toad, placed posteriorly in the body cavity having an external opening called External cloacal opening through which come out urine, eggs or sperms.

(g) **Optic chiasma** :

Just in front of the infundibulum in the brain the optic nerves cross (partly) each other and next the optic nerves proceed in front to form the retina of the eyes The crossing is called the Optic chiasma.

1944

FIRST PAPER

[Illustrate your answer as far as possible.]

Q. 1. *What are your reasons for classifying both a Maize-plant and a Guinea-pig as living organism? Why one belongs to the plant kingdom and the other to the animal kingdom?*

Ans. For the First Part, See Q 2, Second Paper, 1936 and for the Second Part, See Q. 1, First Paper, 1935.

Q 2. *Describe a typical vegetable cell and give an account of the functions of its various parts.*

Ans. See Q. 1, First Paper, 1935.

Q. 3. *Describe the structures of a pea-seed and the mode of its germination.*

Ans. See Q. 2, First Paper, 1935.

Q. 4. *Compare the fruit of a Maize-plant with that of a Pea-plant.*

Pea-fruit is a pod or a legume. It contains many seeds in each pod The seeds are arranged in two rows of the ventral suture The seeds are exalbuminous.

For the rest, see Q. 2, First Paper, 1936.

Maize-fruit is a caryopsis. The fruits are arranged on regular rows on a 'cob'. This cob is an aggregation of female spikelets which arise from the leaf-sheaths and are covered up by the imbricated glumes from within which issue masses of long silken stigma in the form of a tuft. Each grain is a fruit.

For the rest, see Q. 4, First Paper, 1938 and also Q. 2, First Paper, 1942.

Q. 5. *Give a life-history of Fern.*

Ans. See Q. 5, First Paper, 1938.

Q. 6. *Describe the difference between photosynthesis and respiration.*

Ans. See Q. 2, First Paper, 1939.

Q. 7. *Write short notes on :—(a) Osmosis, (b) Pollination, (c) Underground stems, (d) Transpiration, (e) Adventitious roots.*

Ans. (*a*) See Q. 7(*b*), First Paper, 1942.

(*b*) **Pollination** :

It is a process of transference of matured pollen grains from androecium to the stigma of a matured gynoecium for the purpose of fertilisation.

(c) **Underground stems** :

Some plants while germinating send some of its parts, developed from the plumule, within the soil and keep away from the sun. Here the process of carbon assimilation is not carried on and prepared food materials are sent down by the aerial shoots for storage and nutrition, *e g.*, Tuber of potato, Rhizome of ginger, Corm of ole, etc.

(*d*) **Transpiration** .

In drawing the mineral food materials in solution from the soil, plants have got to suck enormous quantity of water This produces a surplus quantity and they get rid of this surplus quantity of water from the surfaces of the leaves and other parts of the epidermis elsewhere. This process is known as transpiration.

(*e*) **Adventitious**

Ans. See Q. 7(*h*), First Paper, 1940.

SECOND PAPER

[*Illustrate your answers as far as possible.*]

Q. 1. *Describe the various structures of an Amœba and indicate their functions.*

Ans. See Q. 2, Second Paper, 1936.

Q. 2. *Describe the organs of offence or defence in animals like Hydra, Prawn and Toad.*

Hydra :

This animal attacks its enemies by means of its cnidoblasts. These are found in the anterior part of its body and more in the tentacles. By means of these it catches its prey. Each cnidoblast contains nematocyst and an acid fluid. This nematocyst is barbed and contains a short stiff hair-like process called Cnidocil,—this is the trigger When the enemy is within reach, the animal sends its cnidocil into its body. The cnidoblast explodes and the nematocyst is thrown out. The barb pierces the victim and next the acid fluid is poured in and thus the victim is killed. Then it is drawn to the mouth cavity by means of its tentacles.

Prawn :

This animal has two organs for defending itself or offending others—

(*a*) **Rostrum :**

The carapace is prolonged in front into a median serrated weapon between the two eyes This might be pushed into the soft tissues of the enemies and they can be wounded or killed.

(*b*) **Cheleped :**

This is also called Forceps. This the animal utilises for fighting with or seizing its enemies. It has the following parts or segments :—Coxo-, Basi-, Mero-, Carpo-, Pro-podites. The last spincer is the Dactylopodite.

Toad

Its weapons for self-defence are the two jaws It bites the prey or the enemy Sometimes it grips by means of the digits or toes especially with the help of its hallux. This is another means of evading the enemies, *i.e* , by the poisonous excretions from the warts grown on its body.

Q. 3 *What is the general course of blood circulation in the Prawn ?*

Ans. See Q. 4· Second Paper, 1931.

Q. 4. *Compare the urinogenital system of a male and a female toad.*

The urinary system of a male and a female toad is the same. It consists of the following :

(1) Two kidneys : Each lies on the either side of the vertebral column. It is of dark-red colour, lobulated and elongated. At the anterior end of each kidney is attached a multilobulated fat body. Each kidney may be considered a collective glandular body containing a number of malpighian bodies. Each malpighian body consists of a capsule, within which is a glomerule. Each glomerule consists of a vascular network of renal veins and arteries as also the renal portal. Urine that is formed by the glomerules is excreted into its capsule and from the capsule it passes into the tubule and from the tubule to the **Wolffian** duct, *i. e* , the ureter. To this ureter, however, drain a number of tubules.

(2) From the medial aspect of each renal border the ureters run on to the two lateral aspects of the vertebral column and pass posteriorly and ultimately meet together.

(3) This common wolffian duct ultimately open into the **cloaca** dorsally by a common opening.

(4) On ventral part of the cloaca lies the urinary bladder where urine collects.

In a male toad, the reproductive or genital system consists of two testes one on either side Each at the anterior end and on the ventral surface of each kidney. Each testis communicates with the tubules of the kidney on which it is present by means of fine ducts, called **vasa efferentia** Both urine and the seminal fluid pass through the wolffian duct

Each testis is a white elongated glandular body placed more towards the anterior part of the respective kidney. At the anterior end of each testis is found a round-shaped small body, called the **Bidder's organ.**

In a female toad, the genital system consists of two ovaries, one on either side of the vertebral column After the matured ova have been shed into the body cavity of a female toad, they find their way into the **oviduct funnels.** These are two in number, one on either side of the vertebra just lateral to each kidney.

The oviduct funnel is produced into a much-coiled tube called **mularian duct** or oviduct. This oviduct coil proceeds further posteriorly into a dilated tube called the **uterus**. Further behind the two uteri meet and open into the cloaca through the same aperture as the ureters. The ova or the egg cells thus pass into the cloaca from which they come out of the body.

N.B.—Though two different sexes are found in toads harmaphroditism is not uncommon.

(For diagrams of the urinogenital system in male and female toads see any text-book)

Q. 5. *Describe fully the heart of Guinea-pig.*

Ans. See Q 7, Second Paper, 1938.

Q 6. *Draw a diagram of the pelvic girdle of a Guinea-pig and label the various parts.*

Ans. See Q. 6, Second Paper, 1935.

Q 7. *Write short notes on :—(a) Vomer, (b) Nictitating membrane, (c) Medula oblongata, (d) Metamorphosis, (e) Thyroid.*

(*a*) **Vomer :**

It is a slender blade-like bone fused ventrally with the mesethmoid bone of the skull.

(*b*) **Nictitating membrane :**

It is a thin and third layer of eyelid arising from the lower margin of the eye, found in toad.

(*c*) **Medula oblongata :**

It is the prolongation of the hind brain through the foramen magnum It is continous behind with the spinal cord.

(*e*) **Metamorphosis :**

Ans. See Q. 7(*a*), Second Paper , 1943.

(*e*) **Thyroid :**

It is a gut-gland It arises from the pharnyx. It may be single-lobed or bi-lobed or diffuse. It keeps up the blood at a certain standard of health through some internal secretion. Goitre is a disease of the gland.

1945

FIRST PAPER

Q. 1. *Tabulate the difference between an object with life an an object without life*

Ans. See Q. 1, Second Paper, 1936

Q. 2. *Describe plastids, their occurrence and functions.*

Ans Plastids, also known as chromatophores, are sma granular protoplasmic bodies found in plant cells. The textur of the plastids are spongy with a semifluid ground substanc having a nucleus in each

Plastids are of three kinds : (1) Chloroplastids, (2) Chromoplastids, and (3) Leucoplastids.

(1) **Chloroplastids :**

These occur in all green parts of plants. In these parts th plastids contain green colouring matter and hence the nam chloroplasts These are essential to a plant since it prepare sugar and starch in the presence of sun's rays. In absence o sunlight the green substance disappears and a yellow substanc called *etiolin* is developed These are converted into chloroplasts again when brought to sunlight.

(2) **Chromoplastids .**

These are brightly coloured plastids found in variousl coloured nongreen parts of the plants Brightly coloured petal or bracts of a flower contain chromoplasts These are ver important from the standpoint of pollination since owing to th colour of the flowers insects are invited from a distance for th act of pollination. They are also present in fruits. In absenc of light these are converted into leucoplasts and may be converted into chloroplasts in presence of light again.

N. B.—*Thus Chloroplasts and Chromoplasts are known a pigment bearers or chromatophores.*

(3) **Leucoplastids** :

These are colourless bodies. They are bigger in size than either chloro- or chromo-plasts. They occur generally in the underground parts of the plant. They convert the sugar solution into starch for storage purposes. Leucoplasts are converted into either chloro-or chromo- plasts in presence of sunlight.

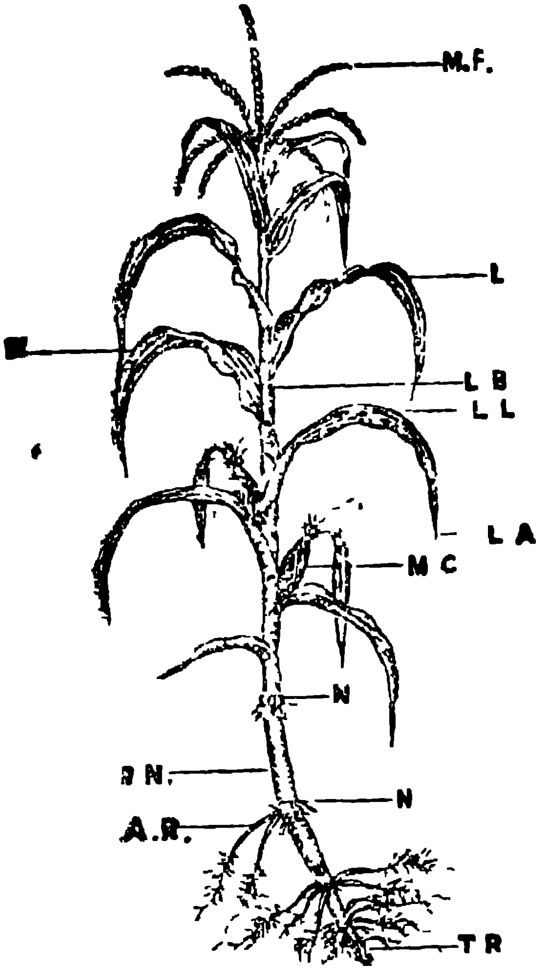
Q 3. *What are the characteristic features of Thalophyta? Explain the differences between Algœ and Fungi.*

Ans. Thalophytic plants are very simple in form. They are not differentiated into roots, stems and leaves. Such a structure is known as *Thallus*. It may be unicellular or multicellular, may be green or not green, parasite or independent. The process of reproduction is found in the following simple ways : either by fission or budding or by spores. Sexual reproduction is also known in thallophytes. Result of such reproduction is a zygote

Differences

ALGAE	FUNGI
(1) Chlorophylls are present.	(1) Chlorophylls are absent
(2) Can prepare food materials themselves from CO_2 and water in sunlight (Autophytes).	(2) Cannot prepare food materials (Heterophytes).
(3) Cannot live in darkness.	(3) Can live both in darkness and in light.
(4) Cell-wall is composed of cellulose.	(4) Cell-wall is composed of chitin.

Q. 4. *Draw and label the various parts of a Maize plant.*



M.F. = Male flower.
L. = Leaves.
M. = Midrib.
L.B. = Leaf-base.
L.L. = Leaf-lamina.
L.A. = Leaf-apex.
M C. = Maize-cob.
N. = Node.
I N. = Internode.
A.R = Adventitious roots.
T.R. = Taproots or true root.

Q. 5. *Describe fully the life-history of Saccaromyces (or yeast).*

Ans. See Q. 7, First Paper, 1935.

Q 6 *What is growth ? What are the conditions necessary for growth ?*

Ans. Growth means an increase in dry weight by the addition of the products of metabolism in a living unit. When anabolism is greater than catabolism, growth takes place. It is one of the vital factors of all living organisms. During growth the terminal part of a plant shows the following phases : (1) Embryonic phase, (2) Phase of elongation, and (3) Phase of differentiation.

The conditions necessary for growth are :—

(1) *Supply of food :* Food is primarily necessary for growth

(2) *Supply of water :* Water is necessary for absorbing minerals from the soil, since a plant takes its food from soil in solution. It also helps in the formation of new protoplasm. It keeps the growing parts turgid and helps growth.

(3) *Oxygen :* Plants respire more at the growing parts and thus energy is set free. For respiration oxygen is taken in.

(4) *Temperature :* Suitable temperature is required for normal growth. Very high and very low temperatures are generally detrimental to the growth of a plant.

(5) *Light :* It is essential to the growth of a plant, at least of the green plants called autophytes. Excess of light retards growth.

Small light affords abnormal elongation with a very low vitality to the plant.

Moderate light is necessary for normal growth.

(6) *Soil :* Suitable soil is necessary for normal growth Suitable soil affords the plant all its necessary minerals and nutrient substances for its normal growth.

Q. 7 *Write notes on* · (*a*) *Oospore,* (*b*) *Azygospore,* (*c*) *Haustoria,* (*d*) *Cambium,* (*e*) *Fruit.*

(*a*) **Oospore** · When a male gamete unites with a female gamete and secrets a cell-wall around the body, it is called an Oospore after fertilization.

(*b*) **Azygospore** . When conjugation or fertilization fails, each gamete develops into a zygospore like structure, called azygospore.

This is Parthenogenesis and hence the spore is sometimes called Parthenospore.

(*c*) **Haustoria** : Generally the parasite plants send in their roots into the epidermal and cortical tissues of the host plants to draw in the nutrient solutions. These roots are called Haustoria.

(*d*) **Cambium** : It is an element of a vascular bundle. It has meristematic property and occurs in between the xylem and phloem (in dicots). This affords the growth of xylem toward its inner side and affords the growth of phloem on its outer side. It is essential for secondary growth.

(e) **Fruit** It is the fertilized product of a matured ovary, sometimes with any other associated parts of the ovary, *e.g.*, Mango, Orange, Lichi, etc.

SECOND PAPER

Q. 1 *Describe the structures by which the following animal bodies take in food —*

(*a*) *Amœba*, (*b*) *Hydra*, (*c*) *Prawn*, (*d*) *Toad*

Ans. For (*a*) Amœba and (*b*) Hydra, see Q. 4, Second Paper, 1941.

(*c*) **Prawn :**

Mandibles and 3rd maxilipeds are utilised for mastication The mouth of the animal is distinct and food is taken by the mouth. It is a large opening on the ventral side of the head and is bounded in front by a shield-like structure called labrum the mandibles lie on the sides like incisors. Just behind the opening of the mouth is a lip-like process called Metastoma or Labium. Just behind the mouth is the buccal cavity.

(*d*) **Toad** ·

It is an omnivorous animal. It generally lives on worms, insects or even plant bodies It takes its food by its mouth The mouth is bounded by two jaws, upper and lower The jaws are toothless, hence the animal does not chew its food but swallows it up The tongue is utilised in catching its prey The posterior part is free and movable, and the anterior is fixed. It can throw the posterior part of the tongue on to the prey and quickly draws it into its mouth cavity to swallow.

Q. 2. *Give an illustrated account of the body-wall of Hydra*

Ans. See Q. 3, Second Paper, 1940 and also Q. 3, Second Paper, 1941.

Q. 3. *Describe briefly the urinogenital system of Leech.*

Ans. See Q 3, Second Paper, 1942.

Q 4. *Give an account of the position and function of the following openings in the body of Bhekti —*

(*a*) *Nasal opening,* (*b*) *Gill opening,* (*c*) *Buccal opening,* (*d*) *Genital opening.*

Ans.

(*a*) **Nasal opening :**

Two pairs, one anterior and another posterior. The anterior pair is guarded by valves. None of the pairs communicate with the mouth.

(*b*) **Gill opening**

These are also called external Branchial apertures and communicate with the mouth. They are situated on the two sides of the head The openings are covered by lids, called Operculum Water passes through the mouth of the fish and is driven out of the gill openings, the dissolved oxygen in the water is utilised in oxidising the waste products of the blood in the gill-plates while carbon-dioxide comes out with the water.

(*c*) **Buccal opening :**

This is the anterior terminal opening. of the body and is bounded by two jaws one upper, not movable and the others lower, movable It takes its food and sucks water in by it mouth which passes out through the gills via pharynx while any food particles coming through water are held back in the mouth and the dissolved oxygen oxidises the impure blood in the gills

(*d*) **Genital opening :**

On the ventral surface towards the posterior end of the abdomen there are several apertures. The most anterior one is the anus, the posterior one is the excretory opening. The middle apertures (paired) are the genital apertures on two sides. These apertures are meant for the expulsion of the ova or eggs and the male generative cells.

Q. 5. *Draw and label the pectoral girdle of a Toad and mention the functions.*

Ans. See Q. 6, Second Paper, 1942.

Q. 6. *Give an account of the alimentary system of a Guinea-pig.*

Ans. See Q. 6, Second Paper, 1937.

Q 7. *Write short notes on · (a) Alternation of generations, (b) Hermaphrodite, (c) Parasite, (d) Compound eye.*

Ans. (*a*) See Q 5, First Paper, 1935.

(*b*) **Hermaphrodite :**

Hermaphroditism is the combination of male and female sexual functions in varying degrees within one organism In leech, earthworm, and in some fish hermaphroditism is clearly seen.

(*c*) **Parasite :**

When one biological unit, plant or animal lives entirely or partly upon another, plant or animal, and draws nutrition from it, the former is said to be the Parasite and the latter is called the Host, *e g* , Monocystis in the seminal vesicles of earthworm , Roundworm in the intestine of man, etc.

(*d*) **Compound eye :**

The eyes of a prawn are said to be compound since it is composed of a peculiar structure, composed of a large number of separate columnar elements called *omatidia.* Externally the eye consists of a circular cornea divided into square facets. Behind this is the corneagen and still behind is the lens which is formed by the thickening of the omatidia in the centre. Posterior to or behind the lens there are some pointed cells, the inner ends of which are called cones. These ends are pigmented retinal layer which is movable.

1946

FIRST PAPER

Q. 1. *Describe the various changes, a nucleus undergoes, during the division of a vegetative cell*

Ans. See Q 2, First Paper, 1936, 1938.

Q. 2. *Describe the structure of a pea-seed and mention the various conditions of its germination with a simple experiment to illustrate them.*

Ans. See Q. 2, First Paper, 1940.

Q. 3. *Prepare a comparative table to show the difference between respiration and carbon assimilation in plants.*

Ans. See Q 2, First Paper, 1939.

Q 4 *Draw and label the various parts of a typical flower. State your reasons for the statement. "The flower is a modified shoot"*

Ans. For the First Part, see Q. 3, First Paper, 1936.

Modified Shoot

That a flower is a modified shoot is supported by the following points .—

(1) The thalamus of a flower is a suppressed stem showing upon it the phylotaxy obeyed by the floral members. It possesses nodes and internodes. Therefore thalamus is a compressed shoot

(2) The floral members in many respects resemble foliage leaves since the sepals and petals possess stomata and venations like foliage leaves and sometimes they bear incisions as in some roses

(3) Like an ordinary shoot a flower arises like a bud sometimes at the axil of a bract leaf

Q. 5. *Draw and label the various parts of dicotyledonous stem after secondary growth.*

Ans. See Q. 4, First Paper, 1937.

Q 6. *Explain alternation of generations from the life-history of a Fern or a Moss-plant.*

Ans. See Q. 5, First Paper, 1938 and Q 5, First Paper, 1939.

Q. 7. *Write short notes on ; (a) Osmosis, (b) Pollination, (c) Transpiration, (d) Reproduction.*

Ans. (*a*) See Q. 7(*b*), First Paper, 1942.

(*b*) See Q. 7(*f*), First Paper, 1938.

(*c*) See Q. 7(*d*), First Paper, 1944.

(*d*) **Reproduction :**

It is a process by means of which a plant gives birth to a new individual just like itself to continue its own race.

SECOND PAPER

Q. 1. *Draw and describe the various structures of an Amœba and state their functions.*

Ans. See Q. 2, Second Paper, 1936.

Q 2. *Give an account of the various modes of reproduction in Hydra.*

Ans. Three modes of reproduction are generally found in Hydra (*a*) Vegetative, (*b*) Asexual, and (*c*) Sexual.

(*a*) **Vegetative** ·

If a hydra is cut into pieces, provided the pieces are not too small and possess sufficient amount of ectoderm and mesoglœa, each piece will develop into a new hydra.

(*b*) **Asexual :**

During favourable circumstances *i e*, when the animal gets sufficient nutrition it reproduces by budding or gemation Each bud after maturation is separated from the mother animal and develops into a new hydra.

(*c*) **Sexual** .

The animal is hermaphrodite It bears both the male and female gamete in the same animal. The male gamete develops on the body of the animal below the tentacles. Here a bud-like out-growth is formed, called testis. This, when matured during spring or summer, is burst setting free a number of sperm cells, each having a rounded head and a lashing tail.

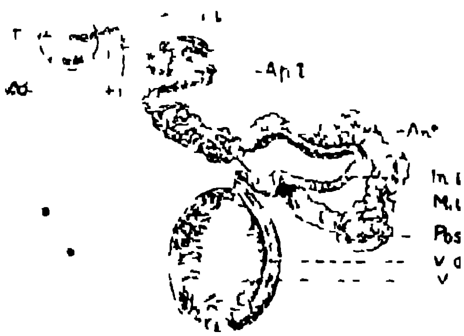
Near the basal disc of the animal develops a bud from the interstitial cells of the ectoderm possessing a single ovum. When the ovum is matured, the ectodermal wall bursts and the ovum is exposed.

Now one sperm cell eventually finds its way into an ovum and fertilises it by fusing completely and surrounds a cell-wall. Thus a zygote is formed by repeated division or segmentation. Thus an embryo is formed which ultimately develops into a full grown hydra.

Q 3. *Describe the excretory system in the Leech.*

Ans The excretory system of leech consists in the nephridia which consists of seventeen pairs. They are situated as follows —

This first pair is situated in the 6th segment and the last pair in the 22nd segment. Each nephridium has the form of a loop consisting of 3 lobes glandular in nature (passing upwards from the ventral body wall), a ciliated organ and a bladder.

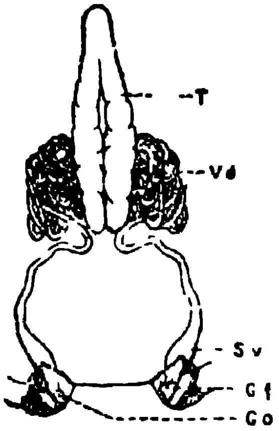


[T.—Testis I l —Initial lobe. V d —Vas deferens. Ap. l.—Apical lobe Ant —Anterior limb of main lobe. In l.—Inner lobe. M b Main lobe. Post.—Posterior limb of main lobe. V d —Vesicular duct. V.—Vesicle]

Nephridia serve the purpose of eliminating the excess of water and also nitrogenous waste matters.

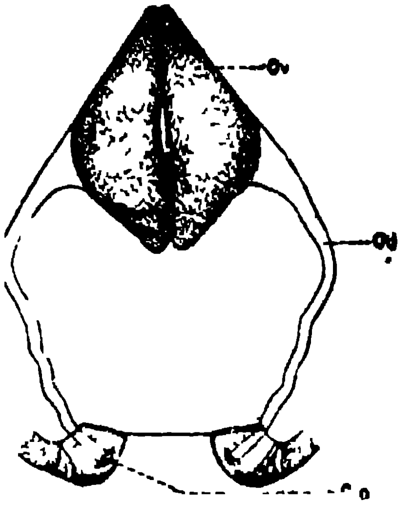
N. B. Each nephridium consists of 3 lobes, the main lobe, and apical lobe and the initial lobe. This third lobe which is long and narrow traverses the other two and ultimately projects over the testis. All the lobes are glandular in character and possess no ducts. The waste products are thrown out through the nephridiospore, *i.e.*, the external opening.

Q. 4. *Draw and describe the male and female reproductive system of a prawn.*



Male ·

(Left)



Female :

(Right)

T.—Testis.
V d —Vas deferens
S v —Seminal vesicle.
G f.—Genital flap.
G o.—Genital opening.

Ov — Ovary
Od. — Oviduct.
G.o —Genital opening.

Ans. The animal bears separate sexes. It is not hermaphrodite. The generative organs lie above the gut and below the pericardium The male animals have broader abdomens than those of the females.

In female animals ovaries are always paired and larger than testes, but the oviducts are short and open into the third coxopodite of the 3rd walking legs.

In the males, the testes are also paired, white in colour and soft. The two fuse anteriorly to form a common lobe. The vas deferens of each testis is long and coiled and opens on the base of the fifth leg. Here each vas deferens forms a swollen body and forms what is known as vesiculata seminalis. In this are found the spermatophores, *i e* , the compact mass of spermatozoa. Each spermatozoon is nucleated and hemispherical in shape. This is the head, from which a tail-like process is prolonged. Spermatozoon is not capable of active movements.

Q. 5. *Compare the aortic arches of Toad and Guinea-pig*

Ans. Three main arches are found in toad on each side. Carotid arch, systemic arch and the plumocutaneous arch. All these arches come out of a common trunk known as "Truncus arteriosus"

Carotid —It is the anterior arch giving off the branches supplying head and brain. Just anterior to its origin it is swollen and is known as **Carotid labyrinth** The branches are external carotid, lingual branch and internal carotid.

Systemic arch :—This is the proper aortic arch and the middle arch on each side. It goes upwards and backwards round the oesophagus and joins its fellow coming from the other side and forms what is known as the median trunk which is straight

In guinea-pig the aorta rises from the left ventricle, advancing forward and then to the left and proceeding backwards in the median planes forming the dorsal and abdominal aorta

The arch of aorta gives off the following branches .—

(1) Innominate artery.

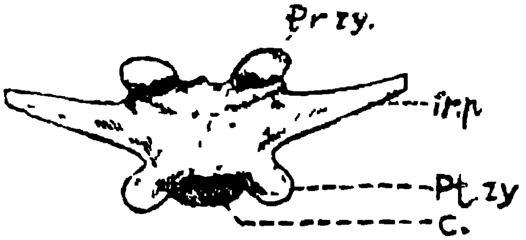
(2) Left sub-clavian artery

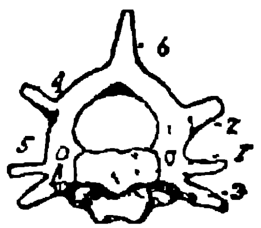
(1) Innominate artery gives off right sub-clavian artery and right and left common carotid arteries.

(2) Left sub-clavian gives off left vertebral and left internal mammary

Q. 6 *Draw and describe a typical vertebra of Bhekti, Toad and Guinea-pig*

1—Centrum,
2—N arch,
3—N canal,
4—Rib,
5—Spine





Ans. Bhekti ·

A typical vertebra of bhekti consists of concave centrum on both sides. The neural arch is low and directed posteriorly. Ventrally directed are the two parapophyses.

Articulating processes are four pairs in number. They are anterior neural, and hœmal, posterior neural and hœmal Zygapophyses.

Toad :

A typical vertebra of a Toad has the following characteristics :—

It consists of a body called *centrum* and an arch above the centrum, called *neural arch.* Thus it forms a ring around the spinal cord. The centrum is *concave in front but convex behind.* A ridge is found on the centre of the arch and is called *neural spine.* There are lateral processes from the sides of the arch and each is called the *transverse process.* There are two other projections, one anteriorly and another posteriorly and these are the articular processes and called *Zygapophyses* The anterior is called the *pre-Zygapophysis*, and points upwards and inwards, but the posterior Zygapophysis points downwards and outwards.

Guinea-pig :

A typical vertebra of a Guinea-pig has the following characteristics :—

The centrum or the body has three parts, two lateral epiphyses which are thin bones and the middle portion is the thickest bone. Each has two epiphyses, anteriorly and posteriorly. Each vertebra has a neural arch and the pre- and post-Zygapophyses All the cervical vertebræ have compressed spine placed antero-posteriorly with transverse processes.

The dorsal vertebræ bear movable articulated ribs. Transverse processes are strong 'Anteriorly the centrum has a small facet. The lumber vertebræ do not possess any facet on the transverse process.

From the body of the first three vertebræ, a short process called *hypophysis* projects downwards. Other accessory processes are also seen. They are anapophyses and metapophyses.

Q 7. *Draw and describe the alimentary system in one of the following animals* —

(*a*) *Bhekti*, (*b*) *Toad*, (*c*) *Guinea-pig.*

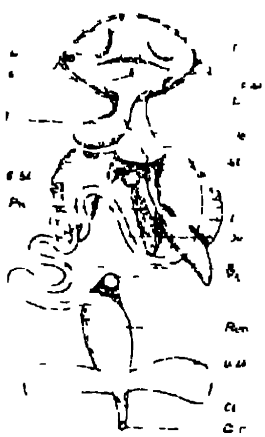
Ans.

(*a*) See Q. 4, Second Paper, 1936.

(*b*) The alimentary system of a Toad begins in the mouth cavity and ends at the posterior extremity of the trunk.

The jaws are toothless. The upper jaw is hard and horny. The tongue is muscular and is attached in front but free behind. In male the *vocal aperture* is found on the left side of the floor but this is absent in female toads. In the roof of the cavity open the *Eustachian tubes*, one on either side, each of which leads into the *drum of the ear.*

After the buccal cavity, comes the *pharynx*. and more posteriorly is the *œsophagus* leading to *stomach* The distal end of the stomach is constricted and this constriction is known as the *pylorus.* Thus the anterior end of the stomach is known as the *cardiac end* and the posterior, *the pyloric end* Next begins the small intestine. The first part is the *duodenum* which is continuous with the *ileum* nearly 4-5 inches long. This is continued backwards as large intestine nearly one inch long This is called the *rectum* which ends in a wide aperture called the *cloaca* which in turn opens to the exterior. There is no anus.



(*c*) See Q. 6, Second Paper, 1937.

1947

FIRST PAPER

Q. 1. *What are the food elements of plants ? How does a green plant obtain its food ?*

Ans The following are the food elements of plant as found from dry analysis and water-culture experiments, for the normal growth of a plant - (*i*) Hydrogen, (*ii*) Oxygen, (*iii*) Nitrogen, (*iv*) Carbon, (*v*) Sulphur, (*vi*) Phosphorus, (*vii*) Sodium, (*viii*) Potassium, (*ix*) Calcium, (*x*) Iron, and (*xi*) Magnesium.

A green plant obtains its food from two sources · (1) Earth, and (2) Atmosphere The root hairs absorb the nutrient materials in solution from the soil and pump it up slowly to the leaves through the xylem vessels, and the leaves by means of their stomatal openings collect carbon dioxide gas in presence of sunlight and store it in the mesophyll tissue Here with the help of the sun's rays, a chemical reaction goes on in the leaves, called photo-synthesis, whereby the carbon dioxide and water of the nutrient solution interact chemically to form what is known as formose HCOH, the precursor of sugar This reaction and further products are brought about by the chlorophylls in sunlight.

$$\left.\begin{array}{l} H_2O = H + H + O \\ CO_2 = C + O + O \end{array}\right\} = HCOH + O_2$$

Thus in the above reaction we find that oxygen is given out in the same volume as the plant takes in carbon dioxide.

This formose or formaldehyde on further change forms what is known as sugar $6HCOH = C_6H_{12}O_6$ (sugar). The next product of carbon assimilation or photosynthesis is the formation of starch with the elimination of water $nC_6H_{12}O_6 = (C_6H_{10}O_5)n + nH_2O$ This is the first visible product of carbon assimilation in the green parts of the plant.

Q. 2. *Describe an experiment to demonstrate that plants breathe. Mention those structures which normally help breathing of plants.*

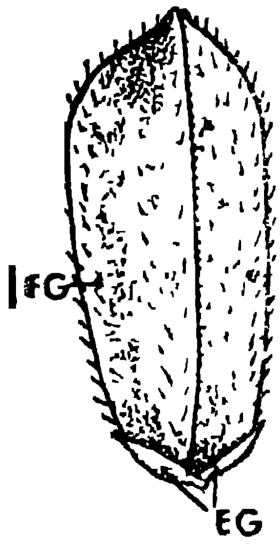
Ans. See Q. 6, First Part, First Paper, 1936.

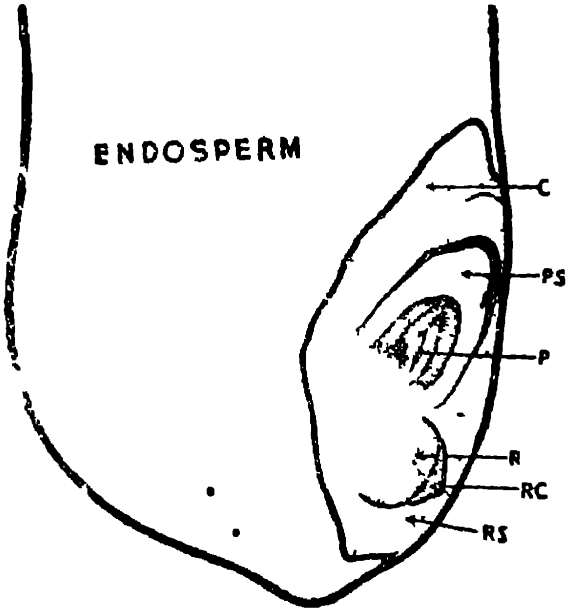
Structures for breathing :

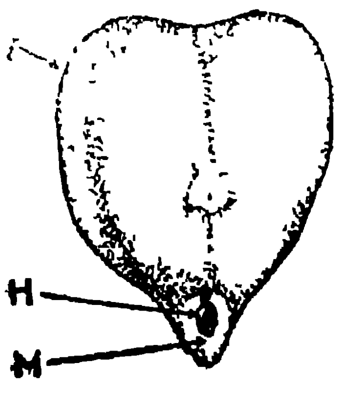
Plants have no definite organs for breathing like those in higher animals All the cells of the plants absorb oxygen. Stomata, Lenticels and inter-cellular spaces help the plants in breathing and thus these are the normal structures meant for the purpose.

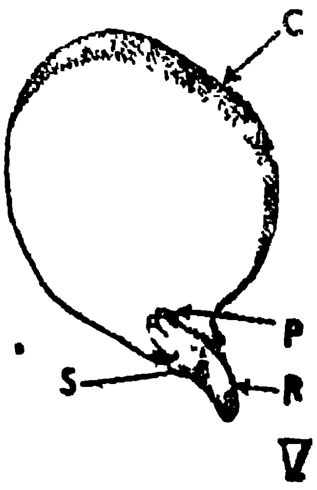
Q 3. *Compare the structure of a Gram-seed with that of a Paddy.*

Ans. The comparison is shown in the following table :—









PADDY	GRAM
1. It is a fruit.	1. It is a seed.
2. Monocotyledonous.	2. Dicotyledonous.
3. 2 Husks enclosing the seed and 2 smaller at the base of the paddy.	3. No husks but testa.
4. Pericarp and seed coat fused.	4. Pericarp and seed coat fused.
5. Albuminous.	5. Exalbuminous.
6. Plumule lateral.	6. Plumule terminal.
7. Cotyledon terminal	7. Cotyledon lateral.
8. Germination is usually hypogeal.	8. Germination is either hypo- or epi-geal.
9. Sheath is present both on the plumule and the radicle.	9. No sheath present.
10 Kernel and Embryo are different.	10. Kernel and Embryo are the same but Embryo is large in gram
11. Scutellum present on the endosperm for absorbing food from it	11. No scutellum.

Q. 4. *Illustrate with suitable examples the different ways seeds are dispersed in nature.*

Ans The seeds are dispersed in nature in various ways. This process perpetuates and spreads the plant species in the different parts of the globe. The following are the means and ways by which seeds are dispersed :—

1. **By water :**

Water lily and cocoanut fruits are dispersed by water. Such eeds are lighter than water and easily float over it. The plants iving in the sea-border or the aquatic plants disperse their eeds in this manner.

2. By wind:

The seeds are light, small, and possess feathery outgrowths, g, Orchid seeds, Sajina seeds, Karobi seeds, Cotton seeds, etc.

3. By animals.

Seeds are often dispersed by the animals either intentionally r unknowingly—

(*a*) Seeds possessing spines or hooks are carried away mechanically by the animals and are scattered in various places, *e.g.*, horekanta, Bagnakh, Apung, etc

(*b*) Sometimes fruits are eaten by animals. Some of the ndigested seeds come out of their excreta and falling on soil row into plants, *e g*, Aswatha, Bat etc

(*c*) Sometimes seeds are gathered from one country and sown n another country and thus cultivated, *e g*, Jute, Pulse, etc.

(*d*) Sometimes seeds are thrown away heedlessly by man, nd plants grow, *e g*, Palm, Date palm, Mango, etc

4 By explosion

Some plants have fruits which, when ripen, burst and the seeds are thrown at a distance and thus the seeds are scattered here and there The fruits of Dopati, Rheri, Amrul, etc when fully ripen, burst and the seeds are scattered at a distance.

Q. 5. *What is the asexual reproduction? How does it differ from sexual? Give examples.*

Ans *Asexual* Asexual reproduction is carried on by spores and not by sexual union The spores on germination give rise to gametes Each spore is a single cell either naked or surrounded by cell-wall In some algæ the spores are found with cilia swimming in water These are called swarm spores or zoospores. The spores that are formed in fungi are smaller and very light so that they can float in air and are transported from one place another, *e g.*, **Yeast, Mushroom, Mucor, etc. The spores of**

fern or moss which are asexually produced give rise ultimately to gametes.

Sexual · In this type of reproduction, the union of two different units or gametes takes place , one is called the male and the other, female. The product of union is a Zygote which sprouts into a new plant. Here each gamete is a single cell. When the two uniting gametes cannot be distinguished the union is called conjugation, *e.g.*, in Spirogyra, Mucor, Yeast, etc. When however they are different, the process is called fertilization. In exceptional cases, however, a female gamete reproduces a plant without being fertilised by a male gamete, as in ferns Such a process is known as Parthenogenesis. Sexual reproduction is found in all phanerogams.

Q 6. *Describe the life-history of a Moss-plant Point out the limits of each generation*

Ans For Ans to the First Part, see Ans to Q. 5, First Paper, 1937

For Ans to the Second Part, see Ans. to Q 5, First Paper 1939.

Q 7 *Write short notes on* **any three** *of the following .—(a Saprophyte, (b) Sieve tubes, (c) Cambium, (d) Starch grains (e) Chromosomes.*

(*a*) **Saprophyte**

Ans. See Ans to Q. 7(*a*), First Paper, 1937.

(*b*) **Sieve tubes .**

Sieve tubes form the major portion of the phloem tissue These tubes are formed not by the complete dissolution of the partition walls either transverse or lateral These tubes are arranged vertically from end to end. In such cases the partition walls are perforated and are called sieve plates There is a thin layer of protoplasm but no nucleus. The protoplasm is continuous from cell to cell by means of these perforated sieve plates.

(*c*) **Cambium :**

Ans. See Ans. to Q. 7 (*d*), First Paper, 1945.

(*d*) **Starch grains :**

It is a carbohydrate and forms grain round the hilum. It may be simple or compound, concentric. Starch grains are stratified It turns blue by iodine There are two kinds of starch. Souble (in hot-water only) and insoluble starch.

(*c*) **Chromosomes :**

During nuclear division by Karyokinesis firstly the chromatin reticulum becomes shorter and thicker and then it breaks up into a number of "U"- or "V"-shaped bodies. Each of such bodies is known as Chromosome.

SECOND PAPER

Q 1 *Compare the various forms of reproduction in Amoeba with that of Monocystis.*

Ans Three forms of reproductions are known in amoeba, (1) Binary fission, (2) Multiple fission or sporulation, and (3) Plastogamy.

1. Binary fission :

The animal shortens all its pseudopodia becoming almost globular Then the body elongates and assumes the shape of a dumble The nucleus divides into two by mitosis Gradually it breaks at the constriction, each portion containing a nucleus and protoplasm. Thus two seperate animals develop from one. This is the most normal way of reproduction.

2. Multiple fission or sporulation :

When the condition becomes unfavourable, the animal reproduces by multiple fission or sporulation. Here the animal becomes converted into a cyst having a three-layered wall. The nucleus divides into a number of daughter nuclei. The cytoplasm surrounds each of the daughter nuclei thus formed and a number of spores are developed each of which is called pseudopodeospore. After the arrival of normal conditions the cyst breaks up and the spores come out, each producing a new animal.

3. Plastogamy :

This is very rare. In this process a number of adult animals fuse together to form a single mass in which the cytoplasm from all the cells unite together but the nuclei remain discrete and they do not fuse. Such a mass is known as plasmodium From this plasmodium young amoebæ grow. Such sort of reproduction is called sexual reproduction

In Monocystis however the reproduction is seen by spore formation only. They are called zygotes since they are produced sexually

The process goes in the seminal vesicle of an earthworm.

In this process two adult trophozoites come near each other and touch by their sides Next this pair becomes rounded off and cover themselves with a cell-wall Thus they remain within the enclosed cell separately and do not fuse together Now the nucleus of each trophozoite divides very rapidly into a number of daughter nuclei and each becomes surrounded by a part of the cytoplasm These daughter nuclei travel towards the periphery of the cell. Thus each daughter nuleus is a gamete.

Now the partitions of the cells are absorbed and the daughter nuclei or the gametes are thrown into one cavity. Next the daughter nucleus of one cell combines with a daughter nucleus of the other cell and completely fuse together After this each combined nucleus pair becomes a zygote

Each zygote becomes a spore hereafter Thus a number of spores are seen in the cyst Each spore has a chitinous cell wall, forming what is known as pseudonavicella The nucleus of each spore again divides into 8 segments with some cytoplasm around each of them and each becomes circumscribed by the formation of a new cell-wall in the form of a sickle and is called a sporozoite At this stage if the particular earthworm is taken up by a bird, the sporozoites pass out of the intestine of the bird along with its foeces and when this infected foeces is taken up by another earthworm the sporozoites lose their spore coat.

and pass out of the intestines of the earthworm and reach the seminal vesicle of it where it ultimately develops into a trophozoite.

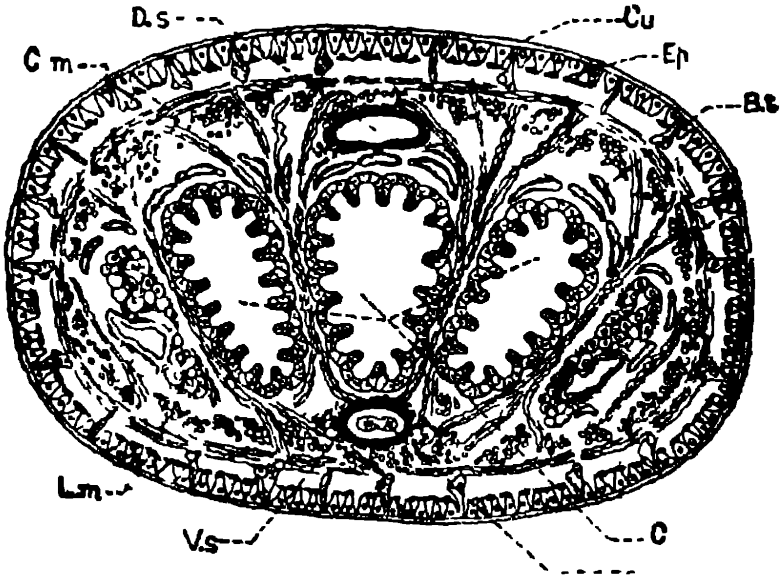
Q. 2. *Draw the transverse section through the body of Hydra and Leech, labelling the various structures.*

Ans. For Ans. to the First Part, see Q. 3, Second Paper, 1937.

Transverse section of Leech :

When a transverse section of the body-wall of leech is examined under the mircoscope, we note the following structures from outside to inside —

Cu—Cuticle
Ep—Epidermis
Bt.—Botryoidal tissue
C—Cropcavity.
V s—Ventral sinus
L.m—Muscle layer.
C m—Circular muscle layer.
D s.—Dorsal sinus.
N.—Nervecord.



1. The outermost covering layer which is denuded very often and regenerated from below It is called the cuticle.

2. Next comes the epidermis consisting of a single layer of cells having their broad bases turned outside and apices turned inside. In between these cells are found glandular cells as also some sensory cells or receptors both of which are the modifications of the epidermal cells.

3 Just below the epidermal layer lies the dermis and this is a connective tissue.

4. Some hoemocoelomic capillaries are found in the connective tissue as also some pigment cells.

5. Next comes the muscular layer. All the viscera of the animal are enclosed by the muscle tissue. This muscular tissue is found in different layers and strands. A circular layer forming a ring round the body of the animal is the outermost of the muscle layers. Below this is the layer of longitudinal layer. Some muscle fibres are seen dorseventrally arranged. Some of them are oblique and others are vertical.

6. Next comes a peculiar tissue called Botryoidal tissue. These are branched canals the walls of which contain a dark pigment. These canals communicate with the hoemocoelomic vessels. Hence hoemocoelomic fluid is seen flowing through these vessels. A greater distribution of the botryoidal tissue is seen especially round the gut of the animal.

7. Dorsal sinus is seen on the dorsal part of the section and a ventral sinus is seen with the nerve cord on the ventral part of the section.

Q. 3. *Compare the eye of a Prawn with that of a Toad.*

Ans.

Eye of a Prawn

It is a compound eye, *i e* , a number of eyelets form the so-called eye of a prawn. The whole eye is stalked and as such can be moved in almost all directions.

Each element of the eye, *i.e.*, each eyelet is called ocellus or ommatidium. The whole eye is covered anteriorly with a cuticular layer called cornea. This is divided into a number of square-shaped facets.

Each ommatidium is thus isolated from each other by means of pigmented layer.

The compound eye forms a number of images, *i.e.*, a particular image for a particular ommatidium on a particular retinula All these images together form a mosaic image of the object seen and the sensation of vision passes ultimately through the optic nerve.

Eye of a Toad :

The eye of a toad is more or less globular and not stalked. It is not compound like that of a prawn.

The outermost layer of the eye is called the Sclera which on anterior surface is continuous with cornea. Next comes the choroid coat. The Iris in front forms the diaphragm of the lens behind having an opening at the centre. This opening is regulated by light. It becomes wider when light is scanty but smaller when light is strong. This opening is called the pupil., Behind the Iris is the bi-convex lens held by ciliary muscles through suspensory ligaments In front and behind the lens the spaces are filled with what is known as aqueous humour. Now, behind this comes the vitreous humour contained in the vitreous chamber. This is a gelatinous substance.

All these structures of the eye beginning from the cornea up to the vitreous humour form a compound lens The Iris is light-regulating diaphragm The image formed by the compound lens (not compound eye) is focussed on the retina situated behind the vitreous humour The optic nerve meets the retina from behind or the retina is continuous with the optic nerve behind. At the junction of the retina and the optic nerve is a depression called *blind spot* and no sensation of image is produced if it falls on this part. Just lateral to this is another spot called *yellow spot* and this is the most sensitive spot on the retina

Q 4. *Describe the circulation of blood in the heart of a Toad.*

Ans. See Ans. to Q. 5, Second Paper, 1939.

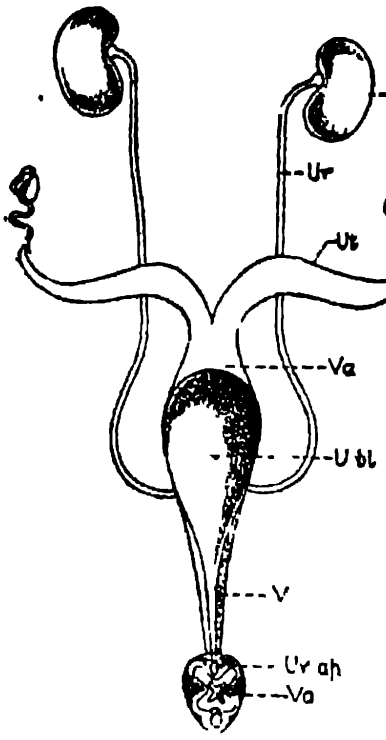
Q. 5. *Give an account of the ten pairs of cranial nerves that are given out of the brain region of a Toad.*

Ans. The whole account of the nerves are given below :

NAME	ORIGIN	DISTRIBUTION	NATURE
1. Olfactory.	Olfactory lobe.	Olfactory bulb.	Sensory.
2. Optic.	Optic thalamus	Eye.	Sensory.
3. Occulo-motor	Floor of mesencephalon.	Four muscles of the eye	Motor.
4. Trochlear.	Posterior part of the optic lobe.	Superior oblique muscles of the eye.	Motor.
5. Trigeminal (having 3 branches) :	All these 3 branches take origin from gasserian-ganglion.		
(*a*) Ophthalmic	As above	snout.	Sensory.
(*b*) Maxillary	”	upper jaw.	Sensory.
(*c*) Mandibular	”	lower jaw, etc	Both, motor & sensory
6. Abducens.	Medula oblongata ventral aspect	Eye-muscles — External rectus	Motor.
7. Facial Branches :	Side of medula.		
(*a*) Palatine		(*a*) Roof of mouth cavity	Motor and Sensory.
(*b*) Hyomandibular.		(*b*) Lower jaw & lower region.	
8. Auditory.	Lateral aspect of medula	Organ of hearing, *i e.*, the Ear	Sensory.
9. Glosso-Pharyngeal.	”	tongue and pharynx.	Motor and sensory.
10. Vagus.	From the lateral aspect of the medula	Heart, lungs, stomach, etc.	”

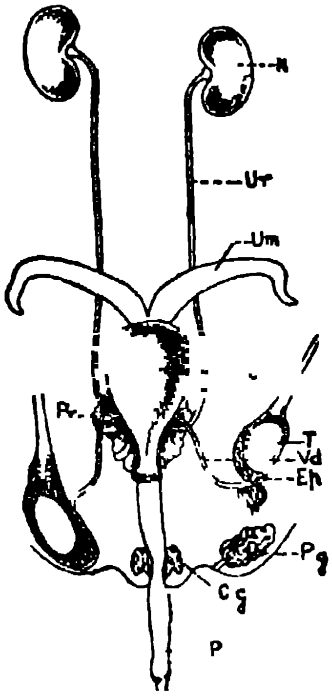
Q. 6. *Compare the urinogenital systems of a male, with that of a female Guinea-pig.*

Ans. (*a*) The urinary system does not differ in its important points in the male and female animals.



(A)

K —Kidney
Ur. —Ureter.
F t.— Fallopian tube.
Ov —Ovary
Ut —Uterus.
Va —Vagina.
U.bl —Urinary bladder
V.—Vestibule.
Ur ap.—Urinary aperture.
Va —Vulva.



(B)

K —Kidney.
Ur —Ureter.
U m.—Uterus masculinus.
T.—Testis.
V d.—Vas deferens
Ep —Epididymis.
P.g.— Perinial gland.
C g —Cowper's gland.
P —Penis
Pr.—Prostate gland

Two kidneys lie in the abdomen by the side of the vertebral column. Each is a bean-shaped organ. The convex border being directed laterally and the concave, medially towards the vertebral column. The medial border of each kidney thus bears a notch called hilum. From this the ureter comes out and passes backward for some time along the dorsal body-wall and finally ends into a pyriform muscular sac called the urinary bladder. The bladder opens to the exterior by a common urinogenital tract.

Each kidney has an adrenal gland placed at its anterior end. Each kidney is covered by two layers of tissue, cortex outside and medula, the inner layer.

Reproductive or genital system :

In Male :

The testes are oval-shaped bodies placed within the abdomen. They come out in matured adults into the scrotal sac, during the breeding time.

A coiled tube, called epididymis remains attached to each testis which is further continuous with the vas deferens which passes through the inguinal canal curves round the ureter of the side and opens into a large bi-lobed sac known as uterus masculinus which in turn opens into the bladder. The urethra is the continuation of the bladder. The urethra lies ventral to the rectum and further behind it is continued to penis.

The posterior wall of the penis is known as corpus spongiosum and the anterior wall is formed of corpora cavernosa The neck of the bladder is surrounded by a mass of gland called prostate Just behind the prostate and dorsal to the urethra, a small ovoid-shaped pairs of glands, called Cowper's gland, is seen.

In Female ;

The gentital system in female consists of the following :— Two small oval bodies, one behind each kidney on the dorsal wall of the abdomen, are formed and kept in position by the peritoneum. Some protuberances are seen on the wall of the ovaries and these are the graffian follicles and some others are formed called corpora lutea.

The oviducts are differentiated into three parts. The most anterior part is called the fallopian tube and is narrow and coiled. It opens into the peritoneal cavity by a funnel-shaped mouth. The median portion is called the Uterus. It is thick-walled and broad. There are two uteri and both of these open anteriorly into the vagina. Here both the oviducts meet and form the vagina. This again is continuous posteriorly with the neck of the bladder forming the vestibule opening at the vulva. On the ventral aspect of this vulva a rod-like structure is seen and it is called clitoris. On the dorsal wall of the vestibule lie two small Cowper's glands.

Q. 7. *Write short notes on* :—

(*a*) *Alternation of generation,* (*b*) *Cœlomata,* (*c*) *Statocyst.*

Ans. (*a*) See Ans. to Q. 7 (*b*), Second Paper, 1943.

(*b*) **Cœlomata** —

The higher animals are called cœlomata. In cœlomata there is a distinct body cavity which is called *coelome.* This may be insipient and degenerate in some cases. The embryo of coelomata are *tripoblastic* as a rule. The adults have their body-wall formed of *three* layers of cells . (1) *Ectoderm,* the outermost, (2) *Mesoderm,* the second layer and (3) *Endoderm,* the innermost or the third layer.

The adult animals are usually *bilateral,*

(*c*) See Ans to Q 7, Second Paper, 1940

1948

FIRST PAPER

Q. 1. *Compare and contrast the life-history of Yeast with that of Mucor.*

Ans. See Ans. to Q 6, First Paper, 1942 and Q 5, First Paper, 1941.

Q 2 *What are annual, biennial and perennial plants ? Give examples of each kind. How would you distinguish between a herb, a shrub and a tree ? When are trees called deciduous ? Name such trees.*

Ans. Plants are classified as herbs, shrubs and trees according to the size and woody nature of the stem and branches :—

Herbs :

Herbs are plants having soft succulent stems and branches, *e g., radish, puin, potato*, etc.

Shrubs :

Plants having distinct woody growth in stems and branches are called shrubs In such plants branches are given out in profuse number, their stems being almost unnoticeable and the branches are given out from the very base of the plants, *e g., Joba, Juthica, Belphul*, etc

Trees :

Plants which develop woody, hard and durable stems and branches, having distinct trunks, erect or inclined are called trees, *e.g., Aswatha, Bat, Mango.* etc.

Annuals :

The plants, that germinate, grow, mature, reproduce and die within one year, are called annuals, *e g., Paddy, Mustard, Gram* and many other herbs.

Biennials :

These are the plants that continue their life-cycles for two years, *i. e.* they germinate, grow, mature and die within two years, *e.g* , *Carrot*, *Turnip* and *Beet* are biennials, generally, in cold countries. In tropical countries however they behave as annuals.

Perennials :

The plants that live more than two years are said to be perennials, *e g.*, all trees and shrubs are perennial plants. *Banana*, though a herb, is a perennial.

Deciduous .

Deciduous trees are those that shed off their leaves during the later winter season and develop new leaves during the advent of spring or summer. During winter, the soil becomes drier than at any other part of the year and some big trees such as *Bat*, *Aswatha*, *Amra*, etc , do not consider fit to maintain their leaves Hence they shed them off But during the advent of spring or summer they need the leaves once more and hence they get them grown on them.

Q. 3. *Describe with the help of properly labelled sketches the changes which a nucleus undergoes during cell division.*

Ans. See Ans to Q 2, First Paper, 1941.

Q 4 *Describe briefly how sexual reproduction in a plant like Maize takes place. What is endosperm and how is it formed ?*

Ans Sexual reproduction or fertilization is the union of a male gamete with a female gamete to produce an oospore and ultimately a seed

The general aspect of such sexual reproduction is described as below :—

The ovary must be matured before reproduction can take place.

The ovule, contained in an ovary, has a single central nucleus in the beginning. During the development for maturity, the single nucleus divides into two, each traversing towards the two polar regions of the ovule. Each of these two nuclei now divides into four. One from each polar region reaches the central portion of the ovule and eventually fuses there forming what is known as the secondary nucleus.

(1) The three micropyler nuclei form the egg apparatus. The upper two are the synergids and the lower one is the ovum or the egg. (2) The three chalazal nuclei are called antipodal cells.

Upon the stigma of such an ovary one or more pollen grains fall and eventually one may develop. The single nucleus within the pollen grain divides into two, forming · (1) Generative nucleus, and (2) Tube nucleus. Next the intine of the pollen grain elongates and protrudes out by piercing the exine and thus forms a pollen tube The lower nucleus is called the pollen nucleus and the upper, the generative nucleus. Next the tube begins to penetrate the tissues of stigma and style till the tip reaches the boundary of the ovule Here the tip of the pollen tube touches the synergids and thus the wall of the tube is broken when the tube nucleus falling within the ovule combines with the secondary nucleus of the ovule and the generative nucleus combines with the ovum or the egg-cell forming an oospore by surrounding itself with a cell-wall.

From this are developed the embryo and the single cotyledon (in maize).

The tubal nucleus or the second male gamete combines and fuses with the secondary nucleus of the ovule (sometimes called endospermic nucleus) This fused mass after rapid and repeated division form a tissue containing food materials. This structure is known as Endosperm and this is the future food of the Embryo

Q. 5. *How do green plants obtain their carbohydrate food? Describe an experiment to show that without chlorophyll carbohydrate synthesis cannot take place.*

Ans. For the Ans of the First Part of the question see Ans to Q. 3, First Paper, 1945.

Experiment :

Take a croton plant. This has got its leaves of different coloured spots on them in addition to its green portions. Such a plant is kept in darkness for sometime, so that the leaves become starch free. Next a leaf is selected and the green portions are carefully marked. After this the leaf is exposed to sun s rays for sometime The leaf is next detached from the plant, boiled in alcohol and tested with iodine solution, under the microscope It is seen that the green portion of the leaf gives blue colour whereas other coloured portions do not respond to iodine coloration. This proves the fact that *without chlorophyll carbohydrate synthesis cannot take place.*

Q 6 *How does a plant grow? Describe an experiment to demonstrate that the rate of growth in different regions of a growing root is not uniform.*

Ans For the Ans. of the First Part, see Ans. to Q. 6, First Paper, 1945.

Experiment ·

The following experiment would show that the rate of growth just behind the tip of the root is greater than that above it.

A gram seedling is taken. One or two roots are selected—each nearly an inch. Each of the roots is marked with Indian ink at equal intervals. This is suspended on the lower end of cork having air-holes which is fitted to the mouth of a wide-mouthed bottle containing water. After sometime those marked roots are observed and it is seen that the space between the markings on the upper part of the root has become longer than before and equal but the spaces between the marking on the lower ends of the roots, *i e*, just above the tips the elongations are greater than those on the upper part but irregular—elongations are greater and greater towards the further ends of the roots. This proves the fact that *the rate of growth in different regions of a growing root is not uniform.*

Q 7. *Write short notes on —(a) Reduction division, (b) Mutation, (c) Stomata, (d) Root-hairs, (e) Dioecious plants.*

Ans (*a*) See Ans to Q. 2, First Paper, 1936

(*b*) **Mutation** .

It is a sudden change in a biological unit, *e.g*, a particular species of evening primrose sometimes gives rise to another species from among a number of them.

(*c*) **Stomata** .

Ans See Ans to Q. 1, First Paper, 1946, or Q. 7 (*d*), First Paper, 1942.

(*d*) **Root-hairs** ·

A little behind the root-cap hair-like outgrowths are given out These are called root-hairs These are unicellular in structure and of exogenous in origin, *i e*, they grow from the outermost portion of the roots The functions of the root-hairs are to absorb nutrient solution from the soil and to secrete an acid substance to dissolve the insoluble salts in the soil so that its absorption is possible.

(*e*) **Dioecious plants**

Male and female gametes may occur in the same plant or in different plants. When they both occur in the same plant, the plant is said to be monoecious. If they occur in different plants, each plant is called dioecious. In gourd-plant male and female gametes occur in different flowers but in the same plant and hence the flower is unisexual but the plant is monoecious. In palm different sexes occur in different plants and therefore it is a diœcious plant. Mango, or Jackfruit plants etc. are monœcious plants.

SECOND PAPER

Q. 1. *Trace the life-history of Monocystis.*

Ans. See Q. 3, Second Paper, 1943, and Q. 2, Second Paper, 1941.

Q. 2. *Describe the body-wall of hydra.*

Ans. See Q 3, Second Paper, 1941.

Q 3. *Draw and describe the circulatory system of a Prawn.*

Ans. See Q. 3, Second Paper, 1940,

Q. 4 *Describe the arterial system of a Toad.*

Ans See Q 5, Second Paper, 1942.

Q. 5. *Compare the pectoral girdle of a Toad with that of a Guinea-pig.*

Pectoral Girdles Compared

Pectoral Girdle of a Toad	*Pectoral Girdle of a Guinea-pig*
1. It is embeded with the body-wall.	1. It is not embeded but gliding.
2. It encircles the anterior body-wall.	2. It is a triangular plate one on each side and placed dorsolaterally and does not encircle the body-wall.

Pectoral Girdle of a Toad	*Pectoral Girdle of a Guinea-pig*
3. It consists of two symmetrical halves which meet ventrally.	3. It consists of only two triangular shoulder blades and do not meet ventrally.
4. *It has the following parts* .— (*i*) Dorsally — (*a*) Scapula, (*b*) Supra Scapula (*ii*) Ventrally .— (*a*) Coracoid, (*b*) Precoracoid, (*c*) Clavicle, (*d*) Coracoid fontanelle, (*e*) no Supra Scapular spine and (*f*) no acromion or metacromion processes, (*g*) glenoid cavity is present. (*iii*) Sternum and Xiphoid process present.	4. *It has the following parts* .— (*a*) Scapula, (*b*) Spine, (*c*) Supra-Scapula, (*d*) Acromion process, (*e*) Metacromion process, (*f*) Glenoid cavity and a knob-like process in the cavity called Coracoid process but no Precoracoid or Epicoracoid, (*g*) Clavicle is very ill-developed. Ventrally sternum and Xiphoid plate are very ill-developed.

Q 6 *Compare the red blood corpuscles of Bhekti, Toad and Guinea-pig.*

Ans. See Q. 5, Second Paper, 1940.

Q. 7. *Write an essay on the evidences of organic evolution.*

Ans. See Q. 2, Second Paper, 1939.

1949

FIRST PAPER

Q. 1. *What are the normal functions of roots? Describe the different forms of modifications of the roots you have examined and mention the special functions they perform in each case.*

Ans. See Q 3, First Paper, 1939 and Q. 3, First Paper, 1942.

Q 2. *Compare and contrast the anatomical structure of a root with that of a stem before the initiation of the secondary growth in thickness. Illustrate your answers with properly labelled sketches.*

Ans. *Comparison*

The anatomical structure of a **dicot Stem** presents the following, as seen under the microscope. (Transverse section) .—

1 The outermost, one-layered epidermis with or without multicellular hairs. The outer walls are generally cutinised.

2. Next comes the cortical region or cortex. This consists of many-layred parenchymatous cells with intercellular spaces. Occasionally, however, collenchymatous or sclerenchymatous cells may be present. This cortex may be divided into (*a*) *hypodermis*, (*b*) *cortex* proper and (*c*) *endodermis*.

(*a*) Hypodermis is the outermost layer of the cortical region where chloroplasts may be found.

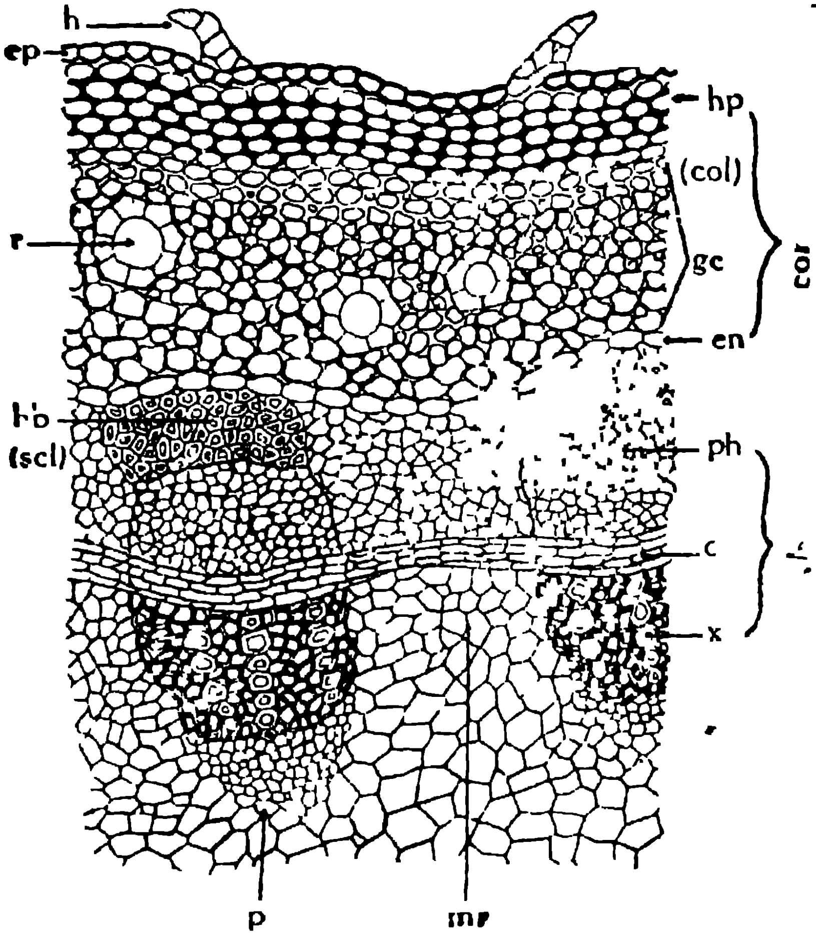
(*b*) The inner limit of the cortical region is called the endodermis—this is also called the starch sheath.

(*c*) The layers in between (*a*) and (*b*) *i.e.*, many-layered portion is the cortex proper.

3. Next comes the Pericycle, generally of one layer or more,

4. Now comes the zone of vascular bundle, arranged in a ring.

Each bundle is wedge-shaped and consists of Xylem towards the centre and Phlœm, towards the circumference. In between the Xylem and Phlœm is the Cambium ; Xylem, again consists of two parts proto and meta. The former towards the centre and the latter towards the periphery. Phlœm also consists of two parts meta and proto. Cambium tissue consists of rectangular cells and of a few layers. This is meristematic.



H—Hair ; Ep.—Epidermis ; Hp.—Hypodermis , Col. —Collenchyma , G c.— General cortex · R.—Resin duct , Cor —Cortex, En.—Endodermis , H.b.—Hard bust ; Ph.—Phlœm , C.—Cambium , X —Xylem ; V.b.—Vascular bundle ; M r —Medullary ray , P.--Pith.

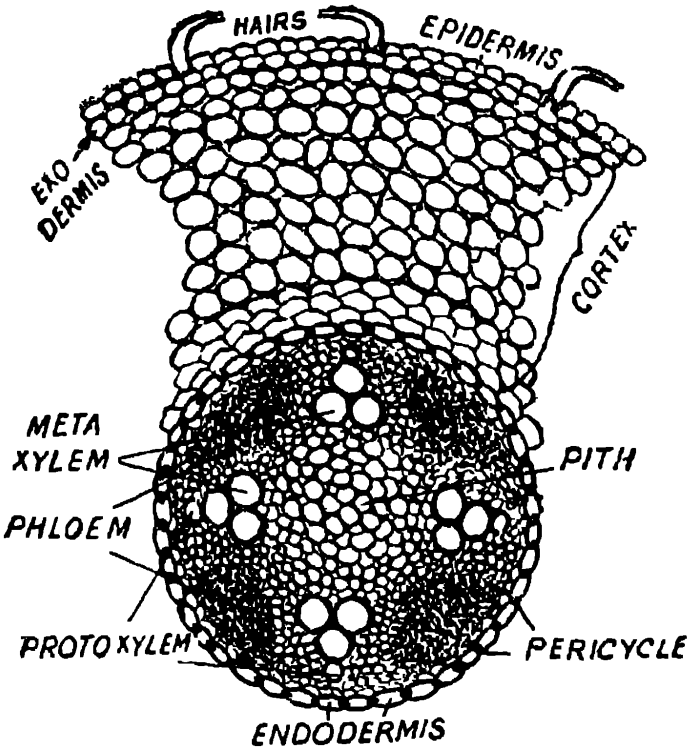
5. The central portion of the section shows the pith. It consists of thin-walled parenchymatous cells of varying size having inter-cellular spaces.

Anatomical structures of a **Dicot Root** as seen under the microscope (Transverse section) :

1. The outermost layer is the epiblema or piliferous layer. It is one-layered, thick and not cutinised. *Unicellular* hairs are found on this layer—no chloroplast.

2. Next comes the cortex This is many-layered region. The first outermost layer of this region is called **exordermis** and the last innermost layer of this zone is called the **endodermis**.

3. In between these two layers is seen a zone of many-layered cells with inter-cellular spaces, having no chloroplasts but leucoplasts, in some cases. In some cases, as in carrot, chromoplasts are found.



4. Next to the endodermal layer is the pericycle. It is usually of one layer of cells.

5. Next is seen the **Bundle zone**. Same number of xylem and phlœm bundles are alternately arranged in different radii. The arrangement is alternate and not collateral or bicollateral as in stem. Protoxylem and protophlœm are towards the circumference or periphery.

6. The central part is generally occupied by parenchymatous cells forming the pith.

Contrast :

Stem	***Root***
1. Cutinised epidermis.	1. Non-cutinised epiblema.
2. Hair, if present, multicellular.	2. Hairs are unicellular.
3. Many-layered cortex	3. Many-layered cortex.
4. Outermost layer of cortex is the hypodermis and last inner layer is the endodermis.	4. Outermost layer of cortex is the exodermis and inner limiting layer is the endodermis.
5 Wedge-shaped vascular bundles arranged in a ring.	5. Bundles are arranged radially.
6. Bundles are collateral or bicollateral.	6. Bundles are arranged in different radii.
7. Protophloem is towards the circumference and protoxylem towards the centre.	7. Both the protophloem and the protoxylem are towards the circumference.
8. Pith is large.	8 Pith is small.

Q. 3 *Describe with the help of properly labelled sketch how fruits and seeds are formed in the Pea or any other plant you have studied.*

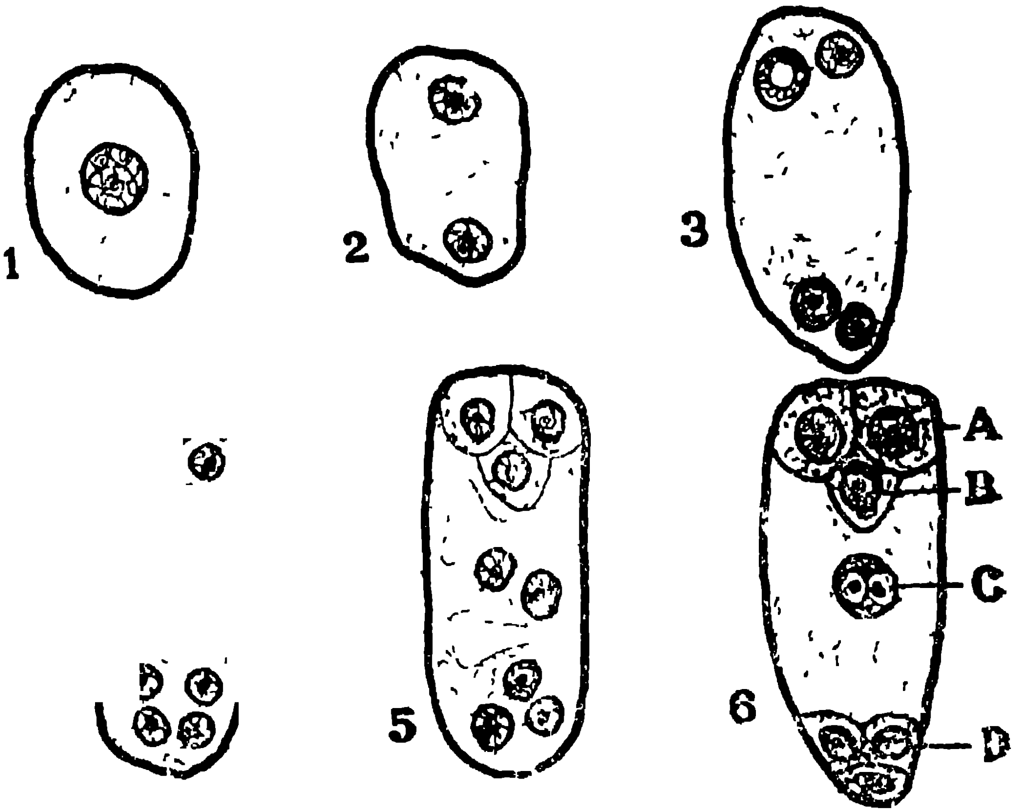
Ans. With regard to a dicotyledonous plant.

Maturation of an ovule :

The nucleus of an ovule first divides into two Each daughter nucleus travels towards each pole of the ovule where each divides again into two and then into four one of these four daughter nuclei from each pole moves towards the centre and fuse together forming what is known as a fused nucleus or secondary nucleus.

Of the three nuclei towards the micropyler pole the uppermost pair is called the synergids or helpers and the lower single one is called the female gamete or egg These three together constitute what is known as egg-apparatus.

The other three nuclei occupying the chalazal pole constitute the antipodals. Each nucleus is surrounded by a mass of protoplasm and thus forms a naked cell. Thus the ovule is now matured and ready for fertilisation.



Maturation of the pollen grain :

Each pollen grain in the anther matures It has two coats ; one, the external, called exine and the other internal called the intine. The exine has a few weak points on its wall First of all each pollen possesses a single nucleus This next, divides into two. One is called the generative and the other, tube nucleus In this condition, the pollen grain is transferred to the stigma of the female flower

When both the male and the female gametes are matured, a pollen grain is conveyed to the stigma of the female flower which secretes a sugary mucilaginous substance at its mouth. The pollen grain here swells up by absorbing fluid from the stigma. The intine forms a tube and ruptures the wall of the exine at a place through which the tube protrudes. The nucleus at its tip is the tube-nucleus and that above it is the generative nucleus. Incourse of time however, the tube nucleus becomes disorganised and thus disappears and the generative nucleus divides into two male gametes—one above the other. This tube gradually passes through the micropyler region and passing through the two synergids reaches the embryo sac. Now the tip of the tube bursts and two male gametes become free. One gamete unites with the egg by process of fertilization and the second one passes to the centre of the ovule and unites with the secondary nucleus (secondary fertilization).

(1) As a result of fertilization, the egg surrounds itself with a cell-wall forming a zygote or oospore. From this oospore the embryo develops.

(2) Similarly, the second male gamete having fertilized the secondary nucleus of the ovule fuses with it completely and forms what is known as endosperm nucleus This soon divides repeatedly and very rapidly to form a tissue of food materials for the future use of the embryo and is called the endosperm.

After, this, some changes go on in the ovule and the ovule is converted into a seed Such one or more ovules may be contained in any ovary. During and after fertilization some changes go on in the ovary as also in some other parts of the particular flower and thus, either the ovary alone or along with the other parts of the flower a fruit is produced

Q 4 *Compare and contrast the modes of reproduction of Spirogyra with that of a fern.*

In Spirogyra we use the following modes of reproduction

1. **Vegetative :**

Some parts, consisting either a single cell or more, are detached from the parent filament and then divide and grow forming new filaments like those of the parents.

2. **Sexual Reproduction** ·

This is effected by conjugation. Two filaments happen to lie side by side and the cells of the filaments grow laterally, protruding towards each other. Eventually each pair meets, the cell-walls are absorbed and form what is known as conjugating tubes. During the formation of the conjugating tube the protoplasmic mass in one contracts from the cell-wall. Now this contracted protoplasm passes into the other tube through a free passage, already established, and fuses completely with the protoplasm of the second. The resulting mass of the protoplasm surrounds with a cell-wall forming a zygospore. This zygospore next germinates into a new spirogyra plant.

Sometimes, however, conjugation having failed a gamete may form a resting spore, called a-zygospore. This spore ultimately gives rise to a new spirogyra filament.

In Fern plants we find the following ·

1. *Vegetative propagation* in some ferns is not unknown. It takes place by the formation of buds on the surface of the leaves.

2. *A-sexual reproductions* by (*a*) apospory as also by (*b*) apogamy are known.

(*a*) In the former case a prothalus develops directly from the leaf.

(*b*) In the latter case the prothalus as formed from the spore produces a shoot without producing sexual organs.

3. *Sexual reproduction* When the spores fall to the ground, each develops a prothalium. It is a thaloid body but self-supporting and independent with regard to the functions of nutrition. It develops rhizoids to absorb nutrient solution from the soil and also develops chlorophyll to carry on carbon assimilation.

Male and female gametes, *i.e.*, antheridia and archegonia develop from the under-surface of each prothallium.

Each antheridium gives rise to a number of multiciliated antherozoids or spermatozoids.

Each archegonium, consisting of a neck and a venter, matures in the meantime. In each venter an oosphere is developed forming a neck canal in pari-pasu, secreting malic acid.

Next one or more antherozoids being attracted by the malic acid reaches the archegonium and *one* of the antherozoids passing through the neck canal unites with and then fertilises the oosphere, which soon surrounds itself with a cell-wall forming an oospore. This, after division develops ultimately into a new fern plant and the prothallus gradually withers away.

Reproduction Compared

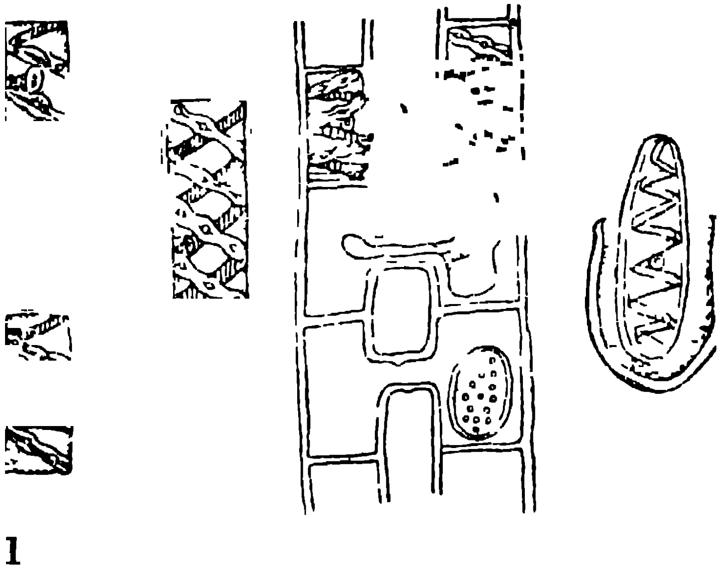
Spirogyra	*Fern*
Vegetative :	*Vegetative* .
It happens by detachment of some part or parts of the filament.	It is effected by the formation of buds on the surface of the leaves.
Sexual :	*Sexual*
This occurs by conjugation.	This occurs by fertilization.
No definite gametes are formed, only the motility in one conjugating cell is seen and this may be called a male strain.	Definite gametes are formed.
Regular alternations of generations are not found in spirogyra.	Regular alternations of generations are seen in fern plant
The plant is a gametophyte.	The plant is a sporophyte.
Prothallus formation is not known. Gametophytic stage is seen clearly but sporophytic stage is seen.	Prothallus formation is known. Both gametophytic and sporophytic stages are seen clearly.

Spirogyra	*Fern*
A-sexual :	*A-sexual* :
Conjugation having failed, a gamete may form a resting spore, *i.e.*, a-zygospore. But apogamy and apospory are unknown.	Apogamy and apospory are known in Fern. In the former, the prothallus directly produces the shoot without being intervened by sexual organs and in latter prothallus is directly developed from the leaf.

1-2. Filaments showing chloroplasts and pyrenoids.

3 Conjugation between two filaments showing conjugating tubes and Zygospore.

4. Germination of Zygospore.



Q. 5. *Describe a simple experiment to demonstrate respiration in plants. Why respiration is called a catabolic process ? What kind of energy is liberated during the process ?*

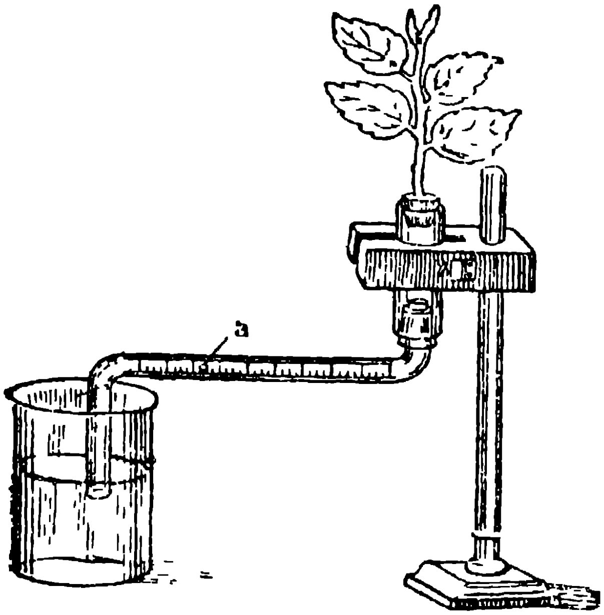
Ans. See Q. 6, First Paper, 1936.

Q. 6. *Describe on experiment to demonstrate transpiration in plants. Explain the uses of transpiration in the life of a plant. Why does a peeled potato shrivel up more quickly than an unpeeled one ?*

Ans. To demonstrate the phenomenon of transpiration in a plant it can be made in the following way :—

Potometric method :

A potometer is an instrument for showing transpiration current in a plant.



Potometer.

Experiment :

Cut a plant branch under water and by means of a cork fit it to the wider end of the potometer. All the connections are made air-tight by means of parafin wax. The other end of the potometer is dipped into water in a half-filled beaker Let an air-bubble be introduced into this limb through the water in the beaker. Keep this for a few minutes. Now it will be seen that the air-bubble travels up towards the free end of the potometer i e. towards the plant along the horizontal portion of the graduated tube. This proves that a process of suction is going on.

Uses of Transpiration :

1. *A plant gets rid of its surplus water by transpiration*

A plant as a rule absorbs nutrient solution from the soil. For this purpose it absorbs enormous amount of water by means of its roots and root hairs. This nutrient solution passes through the xylem vessels and ultimately reaches the leaves. Here the mineral salts necessary for the manufacture of foods are kept and also some amount of water. The excess amount is thrown into the atmosphere in the form of vapour. This process is regulated by the protoplasm of the cells of the plant and also by the cuticle and stomata. If this excess of water is not thrown out, the plant-cells might be water-clogged and the cells would die as by drowning.

2. *Transpiration keeps the plant cool ;*

During transpiration water goes away in the form of vapour and in so doing some amount of heat is given out by the plant to help evaporation and this heat is utilised as latent heat of vaporisation. Thus the plant loses some amount of heat and gets cooled.

3. *Transpiration increases the concentration of the cell-sap ;*

The nutrient solution, in a very dilute condition, rises from the soil to the leaves. Excess amount of water having been evaporated, the solution becomes concentrated.

4. *Transpiration helps the ascent of nutrient solution from the soil*

The continuous process of transpiration sets up a sort of suction force from the root hairs to the leaves and hence a continuous ascent of nutrient solution goes on through the xylem vessels and reaches the leaves.

5. *Transpiration helps the growth of the plant :*

By transpiration the cells alternately become turgid and relaxed and by this turgidity, the cells elongate and thus the plant grows in volume.

In an unpeeled potato the evaporation of the water from inside the potato is regulated by the cuticular layer covering the potato and also the protoplasm of the living cells of the tuberous shoot. But when the potato is peeled off at least the superficial layer of cells of the potato dies immediately and also the cuticular layer being removed ordinary process of evaporation goes on and not the process of transpiration. Thus the factor to regulate transpiration having been destroyed more evaporation goes on and hence it shrivels more quickly than when not peeled.

Q. 7. *Write short notes on the following ;*

(*a*) *Symbiosis,* (*b*) *Compound leaves,* (*c*) *Chromosome,* (*d*) *Natural selection.*

Ans.

(*a*) *Symbiosis :*

It is a mode of life where two organisms live togethe mutually, one helping the other. Thus in Lichen, an algæ lives with a fungus by rendering mutual help to each other. In Leguminous plants we see some bacteria live in the roots by forming nodules. Plants as a rule cannot assimilate atmospheric nitrogen directly from the atmosphere. The bacteria living in the roots of the leguminous plants transfer atmospheric nitrogen into assimilable form to the plants and the leguminous plants in return to this hospitality supply the bacteria, some carbohydrate food prepared by them. Again in Hydra we find some green algae (called zoochlorellœ) within the endodermic layer and thus supply the animalcule with carbohydrate and take carbon dioxide and nitrogenous salts from the animalcule. Thus they live symbiotically.

(*b*) *Compound leaves* .

See Q 7 (*f*). First Paper, 1940.

(*c*) *Chromosomes*

See Q. 7 (*e*), First Paper, 1947.

(*d*) *Natural selection* :

Darwin observed that organisms multiply in an enormous rate and if there be no check to this, the limited supply of food and space will not be sufficient for all the members at the same time. Hence nature exerts her discretion and influence over them. She prefers some of them and rejects others. Thus the members dear to nature survive and the disliked ones perish giving room and advantage to the fittest The fittest are those that can adopt themselves according to the environment and circumstances. This mode of existence in harmony with nature is called *Natural selection*.

SECOND PAPER

Q. 1. *Give a description of the structures that can be found in the body of an Amœba and mention its function. Give a description of the various modes of reproduction in Amœba.*

Ans. Answer for the structures see Q. 2, Second Paper, 1936. —Page 214

Modes of reproduction :

1. By fission into two In favourable nutritive conditions the animal divides into two.

2. In unfavourable conditions however, the animal reproduces by cyst formation. The whole body becomes globular and secretes a chitinoid cell-wall round itself lying dormant at this stage for some time. When favourable conditions appear, the cyst bursts and the animalcule springs up into activity once more.

3 Reproduction by conjugation of two amœbæ is not unknown.

4 Spore formation is, of course, very rare in this animal.

Q 2 *Show that Hydra is a lower form in the animal kingdom. Give a description of its peculiar organ of defence.*

Ans Hydra is the lowest representative under the phylum cœlometa This phyllum is divided into four classes, *viz.*, (1) Hydrozoa, (2) Acraspeda, (3) Anthozoa and (4) Ctenophora.

Hydra represents a type in Hydrozoa. The genus Hydra includes a number of species and are widely distributed in fresh water.

Hydra represents the simplest form of cœlentera. Its body-wall consists of only two layers and called *diploblastic.* The two walls are loosely cemented together by means of a jelly-like substance called mesoglea. It is merely a double-walled tube. The tube has an opening at one end called mouth. Surrounding this opening of the mouth is a whorl of tentacles numbering ten to twelve.

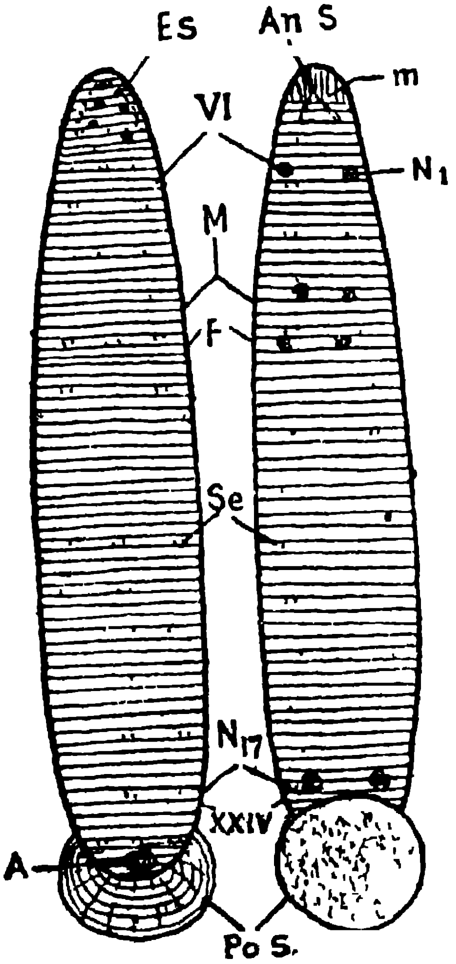
Hydra is so simple that a cut-off fragment may grow into another animal.

Hydra reproduces some times by dividing itself across the middle or by producing buds. In addition to these, both sexual and a-sexual modes of reproduction are common with the animal.

Thus considering the above points, Hydra is considered to occupy a lawer position in the animal kingdom.

For organ of defence, see Q. 2, Second Paper, 1938.

Q. 3. *Draw and describe the various apertures in the body of a Leech and mention their functions in each case :—*



Es.—Eyes.

Ans.—Anterior sucker.

m.—Mouth.

N_1—First Nephridiopore.

M —Male genital aperture.

F.—Female genital aperture.

Se.—Sensillæ

N_{17}—Seventeenth Nephridiopore.

A —Anus.

Po.s.– Posterior sucker.

Ans. The following are the various apertures found in the body of a Leech.

1. *Dorsally* where the posterior sucker is attached to the

body trunk of the animal, the anal opening is situated. This is the extreme posterior opening of the digestive gut through which the excreta is expelled to the outside.

2. (*i*) *Ventrally* seventeen pairs of the openings of the excretory ducts are situated The first begins from the last annulus of the 6th segment and the last is situated on the last annulus of the 22nd segment These excretory ducts are called **Nephridiopores** The function being one of excretion of nitrogenous waste products of metabolism and excess of water.

(*ii*) In the middle of the anterior sucker lies the opening of the mouth or the anterior end of the digestive tract. It is triradiate in shape, teeth and salivary papillæ being within the mouth cavity With the help of this mouth the animal takes its food, *i e* , blood

(*iii*) Leech is hermaphrodite and hence each animal bears both the generative organs The male generative organ is more anterior than the female one

The male genital aperture lies by five annuli in front of the female genital aperture The middle annulus of the tenth segment bears the male aperture and the female is situated in the eleventh segment Thus each lies in the two successive segments.

Through the male genital aperture protrudes out the penis rom which spermatozoa come out during copulation between wo animals

The female genital aperture on the body surface leads into he vagina. The ova are shred off and rest in the vagina before hey are fertilized by copulation and this aperture receives the enis of an other animal during copulation

Q. 4. *Draw and describe the various organs of locomotion in resh water Prawn.*

Ans. The organs of movement of a fresh water Prawn are he following —

(1) *Forward movement by creeping or crawling by walking egs.*

(3) *Backward movement by tail strokes.*

(3) *Swimming about, by swimeret or pleopods.*

1. Walking legs :

When the animal moves forward in a creeping or crawling manner, it uses its five pairs of walking legs. This movement is not very brisk but gradual and slow.

Each walking leg is long and almost cylindrical in shape. Each leg consists of seven parts. Two parts constitute the protopodite and the rest five parts represent the endopodite Exopodite is wanting in a walking leg. The first and the second walking legs bear chela at the end by which it can catch its food or can defend itself from its enemies The second walking leg is appreciably long and stoutest In male, it bears spines. The proximal segment and the next represent the protopodite and called coxa or coxopodite and basis or basipodite. The next five constitute the endopodite and is known successively as, ischium, or ischiopodite , merus, or meropodite , carpus, or carpopodite , propodus or propodite , dactylus , or dactylopodite

Dactylus is the distalmost part of the leg The first and the second walking legs on each side, *i e.*, the 9th and the 10th appendages, each bears pincers or *chela* and hence called *cheliped.*

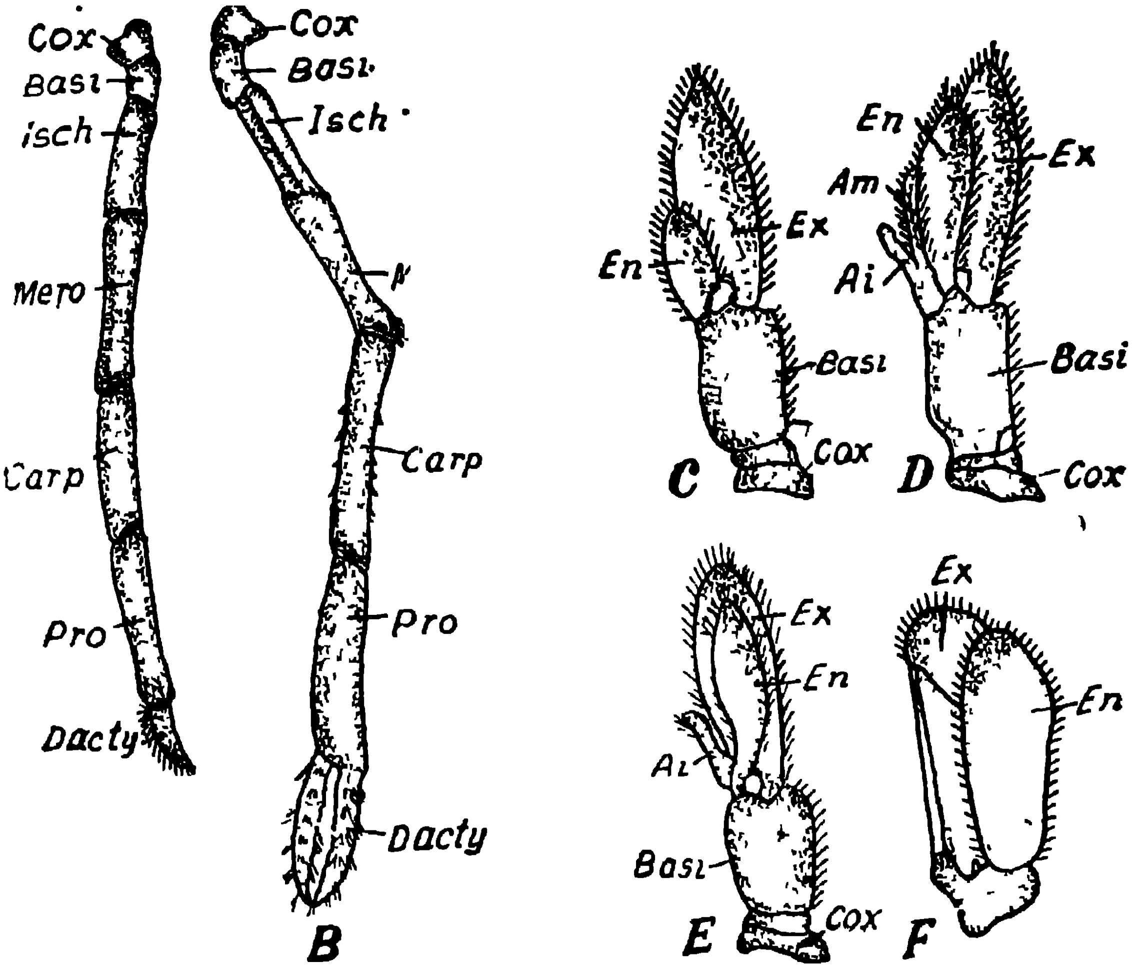
The coxopodite of the third walking leg bears the genital opening in female and the coxopodite of the fifth walking leg bears the genital opening in male.

2. Swimerets :

Swimerets or pleopods are the six pairs of abdominal appendages. They help the animal for swimming about Each swimeret has a coxopodite and a basipodite of which the former is shorter than the latter Each however is possessed of a number of bristles. Each basipodite of a swimeret bears two leaf-like rami—an outer, the exopodite and an inner, the endopodite , and each of these have setæ along its margins. From the **second** to the **fifth** pleopods, each bears a short thin process, called *Appendix Interna.*

In the second swimeret of the male animal we see another very small process, in between the appendix interna and the endopodite, and it is called *Appendix Masculina.*

The sixth or the last pleopod together with the telson form what is called the *uropod* or the *tailfin*. This particular process helps the animal for backward movement even sometimes jerky.



Q 5. *How does blood pass through the heart of a Toad ?*

Ans. See Q. 5, Second Paper, 1939.

Q. 6. *Prove that Bhekti fish is a lower form of an aquatic vertebrata and Guinea-pig is a higher form of land vertebrata.*

N B. The question requires a comprehensive and complete idea of a student, regarding the phylum of each of the types, so that he may do full justice to the question.

It was so decided by the Head Examiner that the answer should contain only a few points proving that Bhekti is a lower

form of vertebrata and Guinea-pig is a higher form. Full credi has been given to a student answering in the above manner.

Ans. That Bhekti is a lower form of vertebrata can b proved from the following facts :—

(1) Bhekti is an aquatic vertebrata breathing by gills having paired and unpaired fins. The pectoral and pelvic pair of fins can be compared with the fore and hind limbs of Guinea-pig or any other higher vertebrata.

(2) In addition to the above paired fins it has unpaired dorsal, anal and caudal fins.

(3) It has no distinct neck.

(4) It has no distinct tail as prolongation of the vertebral column.

(5) It has two pairs of nostrils but none of them lead to respiratory apparatus through the mouth. It respires by gills and not by lungs. The nostrils are used to smell and not fer breathing

(6) The eyes do not possess eyelids but nictitating membranes.

(7) It has no hairs but the body is covered with ctenoid scale (not cycloid)

(8) The body cavity is not divided into thorax and abdomen by a partition wall called diaphragm.

(9) It has a swimbladder and it inspires air into it when it comes to the surface of the water. Thus it helps the animal to float easily.

(10) Bhekti is oviparous, *i e*, it produces eggs and not young ones.

(11) It has no separate genital opening but either the male gonads or the ova in female come through the same passage, called the urinogenital sinus situated with the anal depression.

(12) In males there are two genital ducts but in females no ducts. But the germ cells always come through the urinogenital opening.

In a Guinea-pig, however, we note the following indications and evidences in its being a higher class of vertebrata :—

(1) It is a terrestrial animal.

(2) It respires by lungs.

(3) It has two pairs of limbs, fore and hind, which support the body-weight—each limb has digits at its lower end. Each of the fore limbs has four horny digits and each hind limb has three.

(4) The whole body is divided into three regions, *viz.*, Head, neck, and trunk.

(5) The vertebral column is terminated posteriorly not into a tail but a vestigeal remain of it, called root. A true tail is wanting.

(6) The whole body is covered with hairs.

(7) Eyes have two eyelids each with eye lashes. Each eye has in addition a nictitating membrane.

(8) The animal has two external auditory openings on the two sides of the head with external flexible expansion called pinnæ.

(9) In front of the snout it has two nasal slits called anterior nares leading to nostrils

(10) There is a tuft of stiff hairs lateral to the nares and below the eyes on each side, and is called vibressœ functioning as a tactile organ.

(11) It is a warm-blooded animal and not cold-blooded as Bhekti.

(12) It possesses four or five pairs of mammary glands called mamma or teats on the ventral part of the trunk or abdomen. Its young is nourished by milky secretion from this gland in females

(13) Its thorax and abdomen are completely separated from each other by a muscular wall called Diaphragm

(14) The animal is viviparous. Its young one remains attached to its mother's body till it is fully developed.

(15) (*a*) The copulatory organ in male is known as penis. The terminal aperture in the penis of male is the urinogenital aperture. It has its testes in the scrotal sac in the body cavity which hang down on both sides of the penis during breeding season.

(*b*) The urinogenital aperture in female is called the valva, situated below the anus and having its anterior margin protruded into a fleshy growth called clitoris. Just behind this lies the urinary aperture.

Q. 7. *Write short notes on :*

(*a*) *Parthenogenesis*, (*b*) *Bidder's organ*, (*c*) *Connective tissue*, (*d*) *Blood*, (*e*) *Cartilage.*

Ans. (*a*) See Q. 7(*b*), Second Paper, 1943.

(*b*) See Q. 7(*c*), Second Paper, 1943.

(*c*) **Connective tissue :**

This tissue develops from the *mesoderm*, *i e.*,the middle layer of an embryo. It derives its further structure from both, ectoderm and endoderm. Thus connective tissue is primarily derived from the epithelium. Its function is mechanical, *i.e.*, to strengthen various other tissues and organs of the body. It may be of various types, *e.g.*, blood, cartilage, bone, areolar, elastic, etc.

(*d*) **Blood** :

It is a liquid connective tissue. It consists of a clear plasma in which the blood-cells or corpuscles are floating. Under some circumstances blood coagulates or forms clot.

Blood, when clots, produces fibrin in which the corpuscles are entangled to form clot and the plasma separates out. Blood corpuscles are of two types : red and white. The red cells are known as erythrocytes and contains hæmoglobin *i e.*, the red colouring substance together with iron. The white corpuscles are called the leucocytes and they are the defenders or soldiers in the body.

(*e*) **Cartilage :**

Cartilage is also a type of connective tissue. It is tough or elastic. It is composed of homogeneous matrix having cavities containing nucleated cells. Cartilage is sometimes deposited with lime salts to form bony connective tissue. Cartilage may be hyaline or fibrous, due to the development of fibrous tissue, in it. The pinna of the ear consists much of cartilage tissue. The medial ends of the ribs are of cartilagenous structure.

1950

FIRST PAPER

Q. 1. *Describe the general appearance of the reproductive parts of a Maize-plant. Compare and contrast the anatomical structures of the vascular bundles of the stems and roots of the group of plants to which the Maize belongs.*

Ans The maize-plant is monoecious producing both male and female flowers in the same plant, but flowers are unisexual. The male flowers develop at the top of the plant and the females at the axils of the lower leaves. Thus they are arranged in different inflorescences.

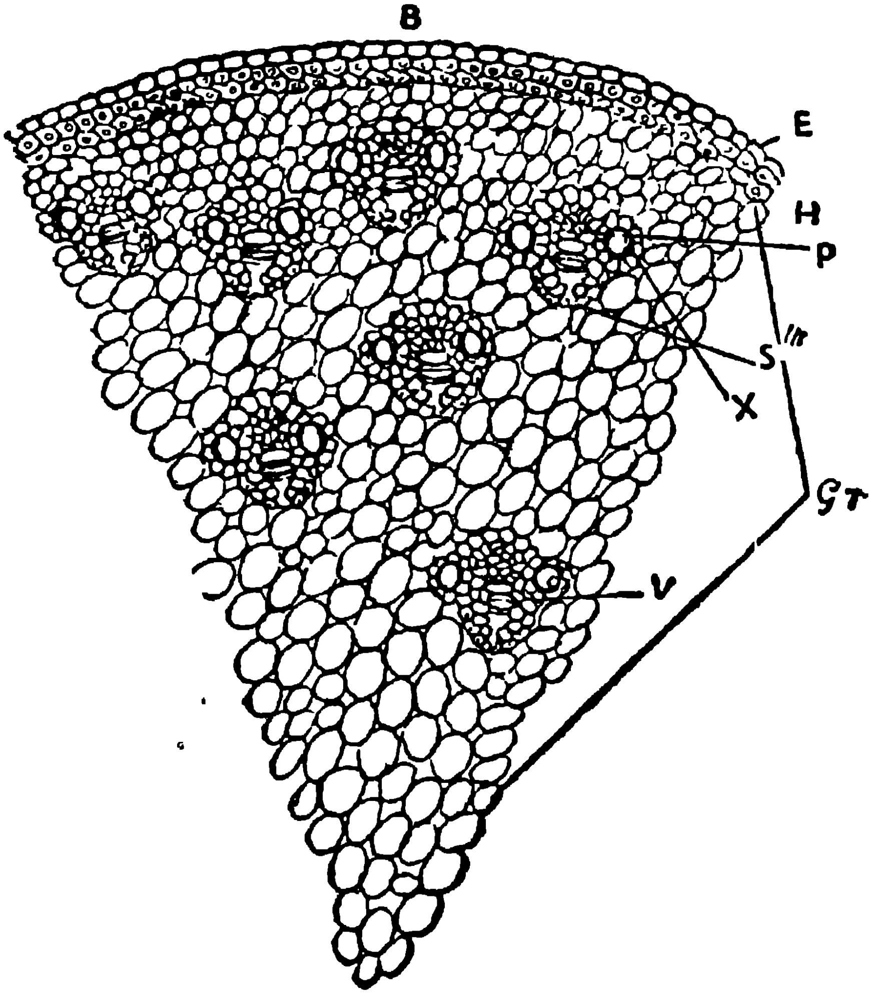
The male inflorescence is a panicle bearing a number of spikelets. Spikelets are produced in pairs, one being sessile and the other stalked At the base of each spikelet there are two empty glumes Two minute fleshy scales called lodicules represent the perianth (*i e* , calyx and corolla) Stamens are 3 in number and the anthers are pendulous.

The female inflorescence is a padix called a cob The number of such cobs in a plant is small. A number of leafy bracts called outer glumes enclose each cob. Each spikelet in the cob is really double flowered of which one is sterile and other fertile. A pair of bracts, which is the outer flowering glume and the inner palea persist in each flower. The fertile flower has one monocarpellary ovary, superior, one-celled. The style is thread-like, silky and very long so that each comes out of the cob and all combined together look like a tuft of heir being exposed to air or outside.

Anatomical Structure

Vascular Bundles :

Stem.—These are scattered in the ground tissue—mor numerous towards the outer side. It is more or less oval i

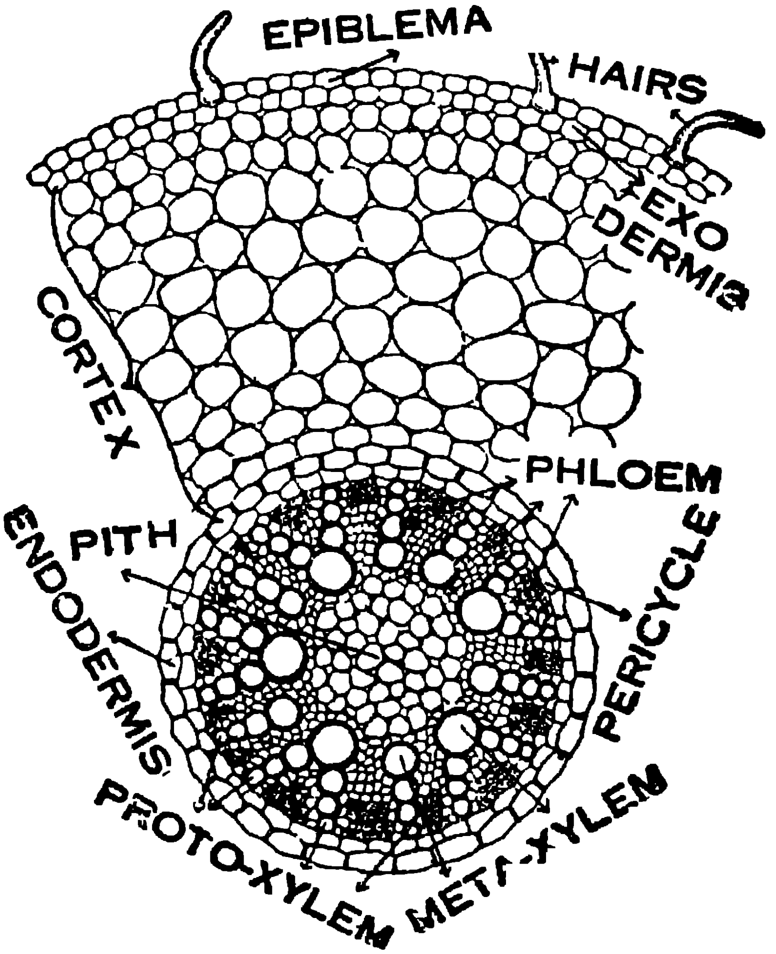


Tr. Sec. of a maize-stem

E.—Epidermis.
H.—Hypodermis.
G. T.—Ground tissue.
V.—Vascular bundle.
X.—Xylem.
P.—Phloem.
S.—Sheath.

shape and provided with scleranchymatous bundle sheat

Metaxylems are two, placed side by side, separated by small vessels. There are two smaller vessels towards one end. There are protoxylems Thus meta- and proto-xylems when joined, form the letter "V", Phloem lies almost within the two arms of "V". Below the closed end of "V" is found the air-cavity.

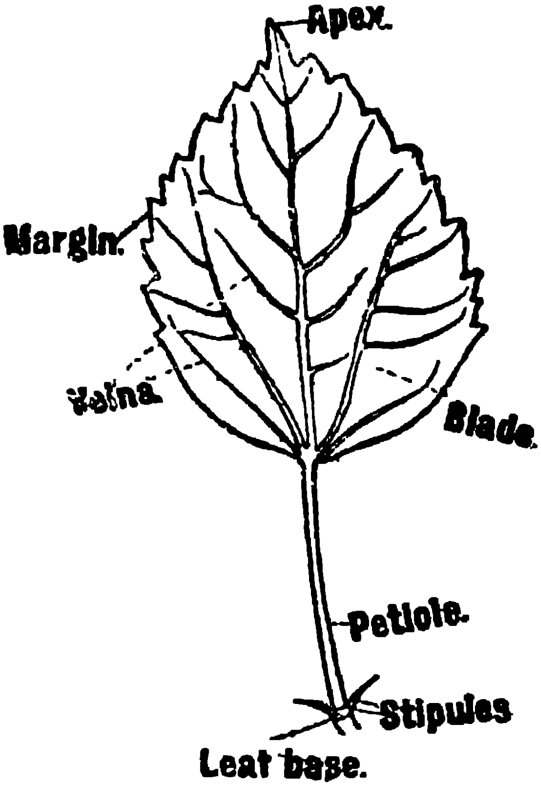


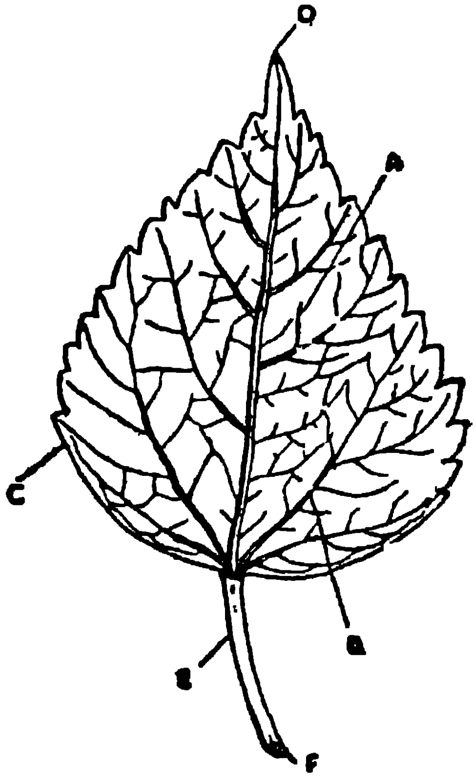
Trans. Section of a monocot root.

Root.—Xylem and phloem bundles are many but all arra ged in a ring and along the alternate radii. Xylem vessels ar composed of both meta- and proto-xylems, the former bein directed towards the centre and the latter towards th circumference.

Q 2. *What are the parts of a typical leaf? What are their respective functions?*

Ans. Part of a typical leaf :—





A = Leaf-lamina or leaf-blade (epipodium)
B = Leaf veins – reticulate.
C = Margin—serrated.
D = Apex—acute.
E = Petiole—present (messopodium).
F = Base of the leaf—(Hypopodium).

A foliage leaf consists mainly of 3 different parts :

(*a*) **Leaf-base**—the portion of the leaf where it is attached to the stem.

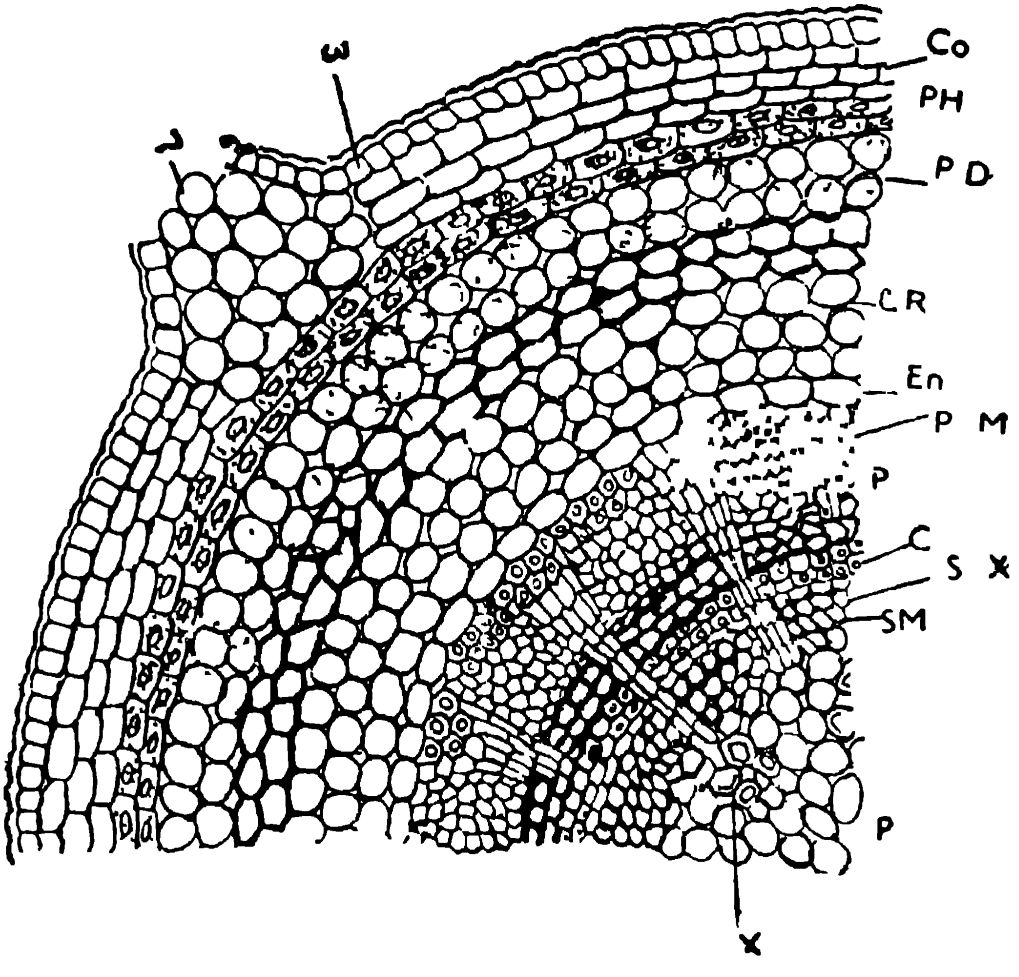
(*b*) **Leaf-stalk or Petiole**—the part of the leaf between the leaf-base and blade of the leaf.

(*c*) **Leaf-blade or Lamina**—the extreme expanded portion of the leaf which is generally flattened.

For the functions see Q. 4, First Paper, 1942.

Q. 3. *What are the non-living tissues of plants after secondary growth in thickness has taken place? Where are they found and what are their structural peculiarities?*

Ans. After the secondary growth in thickness has taken place, mainly two kinds of non-living tissues develop. One, the cork and another the bark.



Trans. Section of the stem of Jaba.

L—Lenticel.
E—Epidermis.
Co—Cork.
PH.—Phelloderm Secondary cortex.
P.D—Periderm.
CR—Primary cortex.
En—Endodermis.
P.M.—Primary medullary ray.
P—Phloem.
C—Cambium.
S.X.—Secondary xylem.
S.M.—Secondary medullary ray.
P—Pith.
X—Primary xylem.

1. Cork :

It consists of almost rectangular-shaped cells having lost their cell-contents very soon. Suberin is deposited on the walls of the cells and thus it becomes impermeable to water. The cells are arranged in such a manner that there is no intercellular spaces. Thus they are compact and hence it acts as a protective layer of tissue to its internal portion. Sometimes however interchange of air takes place through this cork tissue to its inner part by means of a special tissue called lenticell. These lenticells sometimes produce loosely-arranged cells having intercellular space through which exchange of gases takes place. These cells are called complimentary cells.

2. Bark

Tissues, outside the cork, do not get supply of water from the tissues lying to the inner part, therefore they become dry and ultimately die. This is bark Bark layer may be thin or thick The bark, thick or thin, never remains attached to the plant for long It occasionally falls away, *i e* , exfoliates.

Where found :

These are called extrastellar tissues. During secondary growth in thickness, a great tension is thrown upon the epidermal tissues of the stem and root where these extrastellar tissues are formed. Thus they are found generally in the stems and roots on the outer side where secondary growth occurs.

Q. 4. *What do you understand by the terms gametophyte and sporophyte ? Where are the actual starting points of the gametophytic and sporophytic generations respectively in the life-history of Fern ?*

Ans. See First Part, Q. 6, First Paper, 1946.

Second Part :

The fern plant itself represents the sporophytic generation. This generation really begins just after the germination of the oospore into a plant in the prothallus. The plant after its maturity bears spores on the ventral surface of the leaves, called sporophylls. The spores are contained in sporangia which are formed in collection called sorus. When ripened the sporangia burst and the spores are scattered on the ground. Thus all relations of the spores are discontinued from the mother plant. So far goes the sporophytic generation of the plant.

Now comes the prothallus-stage. Each of the spores after they have been strewn on the ground, gives rise to a heart-shaped green structure, called prothallus This is independent of its mother plant It produces root-like structures called rhizoids by means of which it absorbs nutrient solution from the soil. It develops chlorophylls and hence the structure is green and it carries on carbon assimilation with their help. Thus it is self-supporting On it grow the male and female units, antheridia and archegonia respectively. The antheridia produces multiciliated spermatozoids and archegonia give rise to ova in them When matured each spermatozoid fertilizes a single ovum and produces an oospore. Here the gametophytic stage ends

From this oospore the sporophytic generation, *i e.*, the fern plant develops. Thus to represent graphically we have —

→Fern plant (sporophytic)
Sporophyll
|
Sporangium
|
Spor mother-cell
|
Spore—(Beginning of gametophytic generation)
|
Prothallus (gametophytic)
|
Antheridum | Archigonium
|
Spermatozoid or Antherozoid | Oveum or egg

←Fused, given rise to Embryo

Q. 5. *Name the elements which are essential for the normal and healthy growth of a plant. How would you find out that in the absence of any one of these normal growth does not take place? From what sources and in what forms are they absorbed by plants?*

Ans. The essential elements required for the normal and healthy growth of plant are: 1. Hydrogen, 2. Oxygen, 3. Nitrogen, 4. Carbon, 5. Sulphur, 6. Phosphorous, 7. Sodium, 8 Potassium, 9. Calcium, 10. Magnesium, 11. Iron (a trace only).

That the absence of any one of the above elements hampers with the normal growth of a plant can be proved by water-culture experiment and omitting a particular element there.

Normal solution for water-culture experiment should contain the following in a litre of the solution.

Potassium nitrate	·2 grm.
Potassium dihydrogen phosphate	2 grm.
Magnesium sulphate	·2 grm.
Calcium nitrate	1 grm
Ferric chloride	a trace only
Distilled water	1 litre

Eleven jars are taken. Let the first one contain the normal solution as above The other ten solutions are so prepared that each is wanting in one fresh essential element Let one seedling be carefully planted in each solution. It would be found after a time that in the first jar a growing seedling would be growing healthily and normally. But in the other jars similar growing seedlings will be seen suffering in their normal growth in some way or other.

Sources:

For a normally-growing plant the sources from which it derives its food are. (1) Soil and (2) Atmosphere—as ordinary plants do. Water becomes the source of food-supply for all plants and organisms become the source of food-supply for the insectivorous in addition to soil and air-sources.

Forms :

From air the plant takes carbon and oxygen in the form of carbon dioxide gas and free oxygen—sometimes hydrogen and oxygen are also derived from atmospheric moisture in a very small quantity.

The other elements are taken from the soil in the form of their soluble salts in solution.

Q 6. *How does a plant keep itself erect and standing? Of what use is water to the plants? Mention the means of some plants you may have studied where there are large reserves of stored water.*

Ans The plants maintain their erect and standing posture with the help of various mechanical tissues that are developed for the purpose These tissues are distributed sometimes round the periphery where the plant is tall and is subjected to bends due to wind and storm The mechanical tissues may develop within and centrally where such strains are not necessary. These mechanical tissues are usually cutinised or suberised.

Another, the most important factor that play the part of keeping a plant erect, especially the younger growing parts, is turgidity. Turgidity is the condition of being tense and tight. This happens due to the collection of greater amount of water in a cell. The cell-wall becomes stretched from all directions helping in growth, translocation of food materials, different kinds of movements of which being erect or standing is one.

Uses of water :

A living cell always contains water. Without water protoplasm becomes dead Moreover, water is necessary for the following :—

(1) Conveys food from one part of the plant to another.

(2) It takes an active part in metabolism , thus want of water means want of metabolism.

(3) Its presence in a cell produces turgidity which in turn helps growth, posture and different movements.

(4) It helps photosynthesis, respiration and germination.

Large storage of water is seen in Panthapadap and Banana.

N.B. Some plants can stand dryness for sometime which others cannot.

Q. 7. *Write short notes on* (*a*) *Latex.* (*b*) *Crystalline inoculations in plants,* (*c*) *Capitulum,* (*d*) *Root nodules,* (*e*) *Potato.*

Ans. (*a*) **Latex :**

It is a substance found in laticiferous glands or tissues of some plants, *e g* , Akanda, Rangchitra, Karabi, Banyan, India-rubber, Plantain, etc , generally for self-protection.

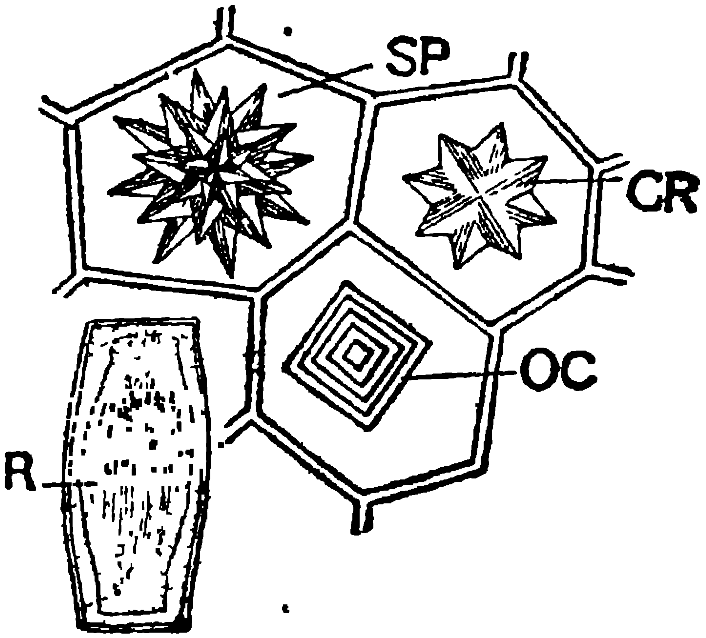
Latex may be *milky* as in Akanda, Rangchitra, etc., may be yellowish white, as in Shealkanta, or may be colourless, as in plantain.

Latex consists of plastic and waste products. Enzymes, gum, guttapercha, starch, proteids, fats, and tannin, etc. are the constituents of latex.

(*b*) **Crystalline inoculations**

Various kinds of crystalline bodies are found in plant cells They may lie in the cytoplasm or may be found embedded in the cell-wall :

I. (*a*) **Raphides** These are chemically calcium oxalate crystals found in needle-shaped clusters in aquatics or monocotyledonous plants such as aroids. (R).



CR—Cubical.

R—Needle-shaped raphides.

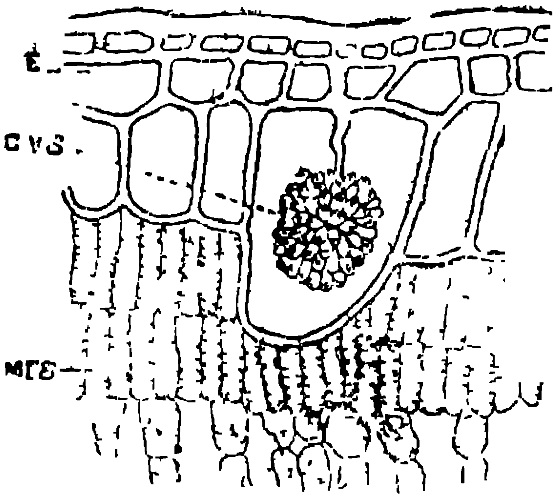
OC—Octahedral.

Sp—Sphæ-raphides.

(*b*) **Sphæraphides** having the same composition as (*a*), but are found in star-shaped bodies as in pistia. (Sp)

II. **Cystolith :**

When a microscopic section of a leaf of Banyan or India-rubber plant is examined under microscope, the inner side of the epidermal cells show the presence of a bunch of substance called cystolith It is calcium carbonate It appears like a bunch of grapes, having a stalk, and a number of crystals are deposited giving the appearance of a bunch of grapes hanging from the stalk. (Cys)



Cross-section of the leaf of India rubber plant, showing
Cys—Cystolith, E—Epidermis,
Mes—Mesophyll

(*c*) **Capitulum**

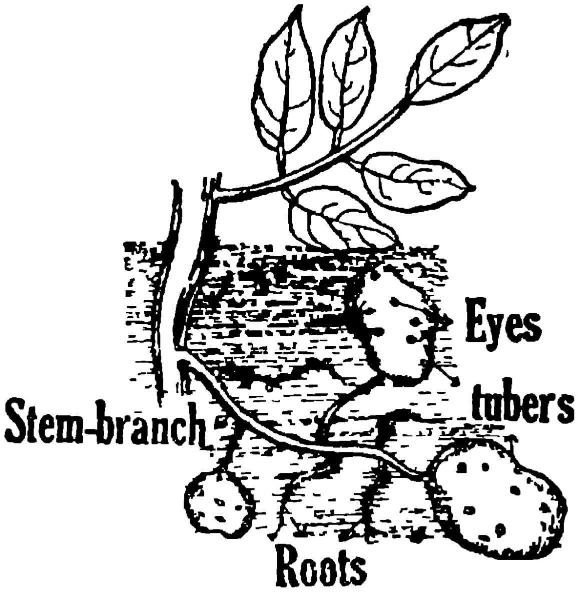
It is a racemose inflorescence in which the receptacle is very ort, flat or convex and the flowers develop centrepetally, each aving an involucre of bracts Two kinds of flowers are seen : ne is called the flowers of the ray and these are sterile, and e other is called the flowers of the disc and these are fertile nd hermaphrodite , *e g* , Sun-flower, Genda, etc.

(*d*) **Root nodules**

In leguminous plants, the roots bear a number of nodules or ubercles underneath the soil. These are the abodes of a few inds of bacteria that live in those tubercles. The bacteria fix the atmospheric nitrogen in assimilable form in the nodules wherefrom the leguminous plants get additional supply of nitrogen which they actually need for their healthy growth. In return to this hospitality the bacteria get carbohydrate food materials prepared by the plants during photosynthesis. Such a life of mutual co-operation is called symbiosis.

(*e*) **Potato** :

Potato is a modified shoot. It is underground modification and is called **tuber**. The "eyes" on the body of the potato are the buds of future shoots and the potato substance is the reserved food of starch for the future shoots growing from the buds as seen in the "eyes".



SECOND PAPER

Q. 1. *Describe the life-history of Monocystis.*

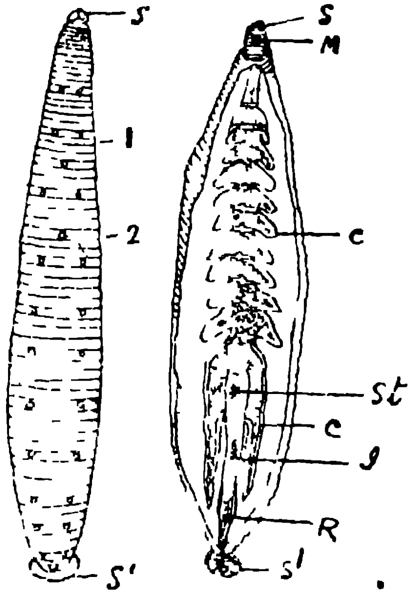
Ans. See Q. 2, Second Paper, 1941.

Q. 2. *Draw and describe the structural peculiarities of the body-wall of a Hydra.*

Ans. See Q. 3, Second Paper, 1937 ; and Q. 3. Second Paper, 1941.

Q. 3. *Describe the alimentary system of Leech.*

Ans. The alimentary system of leech begins from the mouth and ends in anus On the ventral aspect of the anterior sucker is a cup-shaped structure, called the *Pre-oral Chamber.* At its base is the mouth which is guarded by velum and triradiated in appearance This velum forms a partition-wall between the pre-oral chamber in front and buccal cavity behind.



S—Anterior sucker.
Ś—Posterior sucker.
M—Mouth.
C—Crop
St.—Stomach.
I—Intestine.
R—Rectum.
1—Male genital opening.
2—Female genital opening.

In the mouth-cavity there are three jaws, one is dorso-median and the other two ventro-lateral Each jaw bears small cuticular teeth and salivary processes are seen on the sides.

More posteriorly in the mouth cavity lies the pharynx between the fifth and eighth segments. In the pharyngeal region are seen a few salivary processes which liberate a substance that prevents the coagulation of blood, that the animal sucks from another animal The next continuation of the pharynx is the œsophagus. It is very short and is continued behind into a series of successive pouches called crops which are ten in number. Each pouch is almost triangular in shape having two lateral projections on two sides, called "Caeca". The caeca of the tenth pouch is the longest. This last or the tenth chamber leads to the stomach. The junction is well-guarded by a circular muscle called sphinctor.

The stomach lies in the 19th and 20th segments. Next posterior to the stomach is the intestine. The further end of the intestine is narrower than the anterior part of it This intestine ends in a more dilated part of the gut called rectum occupying nearly four segments, from the 22nd to the 26th segment of the body-wall This rectum finally leads to the anus, i e , the external opening of the gut.

Q. 4. *Describe the vascular system of fresh-water Prawn.*

Ans. See Q 4, Second Paper, 1938.

Q 5. *Describe the arterial system of Toad*

Ans See Q 5, Second Paper, 1942.

Q 6. *Compare the respiratory mechanism of Bhekti fish with that of Toad.*

Ans. In Bhekti fish :

Bhekti fish does not take oxygen from air by way of inspiration as other land animals do It utilises the oxygen dissolved in water in which it lives It sucks in the water by opening its mouth into its buccal cavity by expanding the cavity with the help of the muscles there, while each operculum raises its folds covering the gill-chambers, though the branchiostegal membrance at the branchiostegal margins of the chamber keeps the opening airtight while the operculum is raised to make more space

Now the water passes from the buccal cavity to the gill-chambers through the pharyngeal slits The gills are washed with the oxygenated water, and respiratory exchange of gases takes place Next the fish closes its mouth and the muscles press the water, already taken in while the operculum is raised along with the cavity The water goes out of this opening to the exterior under an increased pressure both inside the mouth and the pharyngeal slits.

This process is repeated and the act of respiration is continued.

In Toad :

Animals like toads respire with atmospheric oxygen. In case of Toad, respiration is of two kinds : (*a*) **Pulmonary,** and (*b*) **cutaneous.** When exchange of gases takes place by the activity of the lungs, then it is pulmonary respiration , but when it is made through skin it is cutaneous.

Pulmonary respiration consists of two processes. One is inspiration, *i e* , taking in of air, and another is expiration, *i e.,* giving out of air

During inspiration, an increase of the space in the buccal cavity takes place by the activity of the muscles there Thus air is drawn in through the nostrils which communicate the buccal cavity with the exterior All these happen while the mouth and the glottis remain closed.

Now the floor of the buccal cavity is raised The space is contracted by the relaxation of the muscles The mouth and the nostrils become close and the glottis opens. Thus the air is forced into the lungs through the glottis The lungs, being elastic, expand

Next the process of expiration begins. The lungs now recoil and contract by the joint neuro-muscular action and the air, after oxygenating the blood and being mixed up with the waste products produced during oxidation, is forced out through the glottis by the action of the abdominal muscles and the recoil of the lungs. Now the mouth is opened and the exhaled air comes out of the nostrils and the mouth

Ordinarily cutaneous respiration takes place very slowly but during hibernation in winter this type of respiration goes on mainly.

N. B. *During Tadpole stage, however, it respires by means of its external gills just like other aquatic animals, such as fish.*

Q 7 *Draw and describe the buccal cavity of Toad and Guinea-pig, and compare them.*

Ans.

N. B ***For Diagrams see any Text book on Zoology.***

Toad :

The mouth cavity or the buccal cavity of a toad is bounded in front by two jaws, upper and lower The jaws are toothless, In the front part of the roof of the buccal cavity two small openings of the nostrils are seen. On two sides of the roof two bulgings of the eyes, one on each side, are prominent. Just lateral to the angles of the jaws are seen a small opening on each side. These two openings are of the two eustachian tubes communicating the mouth-cavity with the ear.

On the floor of the mouth is the tongue which is fixed in front but free behind

In male toads a slit-like aperture is seen on the left side of the floor of the buccal cavity. This is the vocal sac-aperture Ordinarily it is hidden by means of the processes surrounding the opening.

Behind the tongue is seen the opening of the **glottis** which ultimately leads to the lungs The narrow vault behind the buccal cavity is the **pharynx.** Further behind and at the posterior end of the buccal cavity is seen an opening of the **gullet** leading to a short tube called **œsophagus** which in turn leads to stomach.

Guinea-pig :

The buccal cavity of a guinea-pig is bounded in front by two long jaws – upper and lower These jaws are covered by lips The upper one is cleft in the middle The jaws bear teeth and these teeth are of different types Hence the animal is called **heterodont** On each side of each jaw there is a toothless gap called **diastema** The upper jaw has on each side a chisel-shaped incisor tooth and four grinding or chewing teeth of which the first is the pre-molar and the last three are molars.

The roof of the buccal cavity is called the palate This is divided into two parts The anterior or the bony part is called the hard palate This bears some transverse ridges. The posterior part is fleshy and called the soft palate. More posterior to the soft palate is the pharynx which further behind leads into **gullet** above and glottis below. The glottis bears anteriorly a small flap like processes called **epiglottis.**

Four salivary glands Infra-orbital, Sub-maxillary, Sublingual, and Parotid open into the mouth cavity by means of their respective ducts. Through these ducts saliva containing an enzyme, called **Ptyaline** flows into the buccal cavity. This helps to make food slippery and digests starchy food into sugar.

On the floor of the buccal cavity lies the tongue This is free in front but fixed behind. It bears some test-buds on its upper surface in the form of papilæ

Comparison

TOAD	GUINEA-PIG
1. Two jaws—upper and lower	1 Two jaws—upper and lower.
2. Toothless jaws	2 Jaws with teeth
3. Prominent bulgings of the two eyes on the roof of the mouth cavity	3. No such bulging.
4 Tongue is fixed anteriorly but free posteriorly	4 Tongue is fixed posteriorly but free anteriorly.
5 Posterior nares opens in the anterior part of the roof of the buccal cavity	5 Posterior nares opens in front of the pharynx.
6 There is no epiglottis proper.	6. There is a cartilaginous epiglottis attached to the glottis
7 There is a vocal sac in the male toad.	7. There is no such vocal sac
8. There is no papillary taste bud on the tongue.	8 There are papillary taste buds on the upper surface of the tongue.

Q. 8. Write short notes on .—

(a) *Metamorphosis*, (b) *Pseudopqdium*, (c) *Retina*, (d) *Cloaca*. (e) *Medulla oblongata*.

Ans. (a) See Q. 7 (a), Second Paper, 1943.

(*b*) **Pseudopodium :**

The term means false foot. It is best seen in amœba. The animal protrudes some protoplasmic projections here and there from its body for various purposes, such as to move from one place to another, to catch its prey, etc. These processes are of various lengths Due to these processes the shape of the animal changes from one to another

(*c*) **Retina :**

See Q 7 (*d*), Second Paper, 1942.

(*d*) **Cloaca**

See Q 7 (*f*), Second Paper, 1943.

(*e*) **Medulla oblongata ·**

See Q 7 (*c*), Second Paper, 1914.

1951

FIRST PAPER

[*Illustrate your answers with neat sketches.*]

Q 1. *Tabulate the difference between plants and animals.*

Ans. See Q 1, First Paper, 1938.

Q. 2 *What is a parasite? Give examples. How is a parasite distinguished from (a) an epiphyte, (b) a saprophyte. Give examples of epiphytes and saprophytes.*

Ans **Parasite**

See Q. 7 (*a*), First Paper, 1938.

(*a*) **Epiphyte :**

"Epi" means upon and "phyton" means a plant. Thus an epiphyte is a plant that grows upon another plant. An epiphyte is an autophyte in other respects. It prepares its own food. It contains chlorophylls. It sends out roots in the air by which it absorbs moisture from the atmosphere. These roots have special structures (velamen) for special functions. Orchids are for example

The main points of difference ·

A parasite depends upon its host plant for either its partial or whole nutrition, according as it is a half or a full parasite A parasite may be green as Manda or nongreen (*i.e.*, chlorophyll may be absent) as Aloke-lata. Parasites send in haustoria into the host plant to draw nutrition from it but an epiphyte does not send in haustoria but produces aerial roots. A parasite does not contain chlorophyll in the roots but an epiphyte does.

(*b*) **A saprophyte** is a nongreen plant and depends upon decaying vegetable or animal matters, *e g.*, Mucor, Mushroom *i.e.*, all fungi. They are generally unicellular and multinucleated *i.e.*, of coenocytic structure. They have no distinct roots, stems or leaves They also differ much in the processes of reproduction. [See Q 7 (*a*), First paper 1937].

Or,

Q. 2. *What is a carpel and what are its different parts? Explain clearly how the different parts of a carpel take part in the process of fertilization in plants.*

Ans. A carpel is a kind of leaf that occurs in a flower. It is a kind of sporophyll. It occupies the central position of the flower or the terminal region of the thalamus. Either one or more carpels from the gynoecium or pistil of a flower. This gynoecium or pistil formed of a carpel forms an ovary, a style and a stigma. The ovary, again, contains, one or more ovules When one carpel forms an ovary, it is called monocarpellary or apocarpous, *e g*, in pea, gram, etc ; but when two or more carpels cohere together, by their margins to constitute one single ovary, then it is called bicarpellary or polycarpellary, *i e*, syncarpous, *e g*, in Dhatura, Jaba, cucumber, etc. Within the ovary at the lowest part of the pistil a particular structure is formed called placenta on which ovules are developed. Sometimes, however, style is not formed and the stigma becomes sensible as in **Kulekhara** (capparis) or **bagnai**

After fertilization the ovary becomes bigger in size and is transformed into a fruit. This transformation may take place only in the carpellary ovary or in other parts of the flower. The ovules become seeds. The two integuments of the ovary become converted into two layers of the seed, called testa and tegmen. Certain other parts of the ovary disappear after fertilization. In some seeds, as of water-lily and others, the nucellus of the ovules act as storage of food for the seed and is then called the perisperm.

Q. 3. *What is pericycle? Describe the nature and the different tissues comprising the pericycle in the stems and roots you have studied.*

Ans. Pericycle ·

It is a layer or layers of tissues that occur on the inner side of the endodermis and outer side of the bundles. This is the position of the pericycle both in stem and its roots. It may be homogeneous or heterogeneous

When homogeneous it is either composed wholly of parenchymatous cells or sclerenchymatous cells, but when heterogeneous it is composed of both the elements interruptedly, *i.e.*, alternately.

Sclerenchymatous pericycle does not occur in roots. In roots parenchymatous pericycle is common The lateral rootlets take their origin from this parenchymatous pericycle. In roots the layer of pericycle is scarcely more than one whereas in stem it may occur in more than one layer and as far as five continuous layers.

N. B. *This kind of tissue, i e , the pericycle is always present in a root but may be absent in some stems.*

Sclerenchymatous pericycle functions as a mechanical tissue but parenchymatous type functions as a storage tissue.

Or,

Q. 3. *How would you distinguish between root and shoot? Enumerate and describe the various forms of modified adventitious roots.*

Ans. See Q. 5, First Paper, 1937 ; Q 3, First Paper. 1940 3, First Paper, 1942 ; Q. 3, First Paper, 1949.

Q. 4. *Some yeast cells are put into a solution of sugar and kept in a warm place. Explain fully the changes that may take place in (a) yeast, and (b) sugar solution.*

Ans. See Q. 5, First Paper, 1935.

Or,

Q 4. *Describe the life history of (a) Spirogyra, or (b) Mucor, or (c) Moss.*

Ans. (*a*) See Q. 5, First Paper, 1936.
(*b*) See Q 6, First Paper, 1940.
(*c*) See Q. 6, First Paper, 1937

Q. 5. *How does a green plant obtain its carbon and nitrogen supply ? Indicate briefly the roles of these two elements in the production of plant food.*

Ans. Land plants, aquatic plants and epiphytic plants have their green-coloured aerial organs either leaf, stem or root. By the help of these green aerial organs, they absorb carbon dioxide from the air and thus obtain the required amount of carbon for them. Thus atmosphere or air is the source of carbon supply for them.

Green parts of plants contain chlorophylls, as a rule. These chlorophylls in presence of sun's rays utilise the carbon from carbon dioxide absorbed from the air and produce carbohydrate, *e. g* sugar, starch, etc. as food for them. The element nitrogen is supplied from various sources. Generally nitrates and ammonium salts in the soil are the sources of nitrogen supply. Some insects also supply nitrogenous organic substances. Leguminous plants absorb nitrogenous materials with the help of some fungi that live symbiotically with them in their roots The nitrogenous materials thus derived are utilised by plants with or without the help of chlorophyll and light The element nitrogen goes to produce various foods for the plants Proteids, Amides, etc are for example.

Nitrogen of food elements after being absorbed combines with carbohydrates to form amides and further when sulphur and phosphorus combine with the amides, protein matters are formed. From these protein matters protoplasm develops.

In some insectivorous plants insects or animals are the sources of nitrogen supply.

Plants never utilise atmospheric nitrogen directly

Or,

Q. 5. *Note any points of interest connected with the following plants* .—

Pea, Banyan, *Patharkuchi* (Bryophyllum), *Phani-manasa* (Cactus), and Ginger

Ans. N B. *Points of interest* as raised in this question, requires the mentioning of either the morphological or physiological characters with drawing

Pea .

The plant is climbing, annual and herbaceous having pinnately compound leaves with foliaceous stipules. The terminal 2 – 3 pairs of leaves are converted into tendrils. In the roots of the plant some bacteria live symbiotically to fix atmospheric nitrogen for the use of the plant.

Flowers are papilionaceous. Stamens are diadelphous (9 + 1). Fruit is a legume or pod.

Banyan :

The plant is a perennial big tree. It lives for many years. It produces prop roots to support the branches from different parts of the branches. It contains milky juice, *i.e.*, latex. Its inflorescence is of cymose type. The rachis becomes cup-shaped. The flowers are small sessile and in number placed within the fleshy cup-shaped, closed rachis having some openings at the top. This sort of inflorescence is called **Hypanthodium**.

Patharkuchi

It is a shade-loving perennial plant having succulent leaves, the margins of which are serrated In these serrations of the leaves of Bryophyllum adventitious buds develop. These buds having been detatched produce new plants vegetatively.

The leaves of this plant is used for medicinal purposes by the Kavirajas.

Phani-Mansha .

It is a zerophytic plant occurring in dry places The peculiar adaptations of the plants clearly point out to its zerophytic nature. It has flat green stems. Such stem is known as plylloclade or cladode. The leaves are transformed into spines.

It is used for medicinal purposes.

Ginger

It is an undergroand stem or shoot. It is thick, fleshy, and bears scaly leaves at the nodes. Aerial shoots are often given off annually from the axils of these leaves. It has distinct nodes and internodes. Rootlets are developed from the undersurface of the Rhizome. Rhizome is never green.

It is largely used as medicine and article of spices.

SECOND PAPER

[*Illustrate your answers as far as possible.*]

Q. 1. *Tabulate the differences between Invertebrata and Vertebrata.*

Ans. See Q 1, Second Paper, 1941.

Q 2. *Describe the various structures in the body of an amœba.*

Ans. See Q. 2, Second Paper, 1936 and 1939.

Or,

Q. 2. *Describe the anatomy of a nematocyst of hydra and the mode of its operation.*

Ans. *Anatomy :* Towards the upper part of the body of hydra the stinging cells or **cnidoblasts** are seen. They are more abundant in the tentacles. No such cells towards the basal part are noticeable.

A cnidoblast cell is seen embedded in the ectodermal layer of the animalcule. It is somewhat jug-shaped, having its narrow end directed outward where a short pointed fine hairlike process is seen. This process is known as trigger or cnidocil. Towards the inner part of the ectodermal layer of cells, there is a sac. To the narrow end (which is directing outward) is attached a long hollow threadlike process. This remains coiled within the sac. The whole sac is surrounded by a mass of protoplasm having a prominent nucleus. This hollow, long, threadlike process is known as **Nematocyst.**

Nematocyst is the weapon of defence and for catching prey There are three types of nematocysts :

(1) **Penetrant** :

It throws out a long thread and possesses barbs at its base.

(2) **Volvent** :

It is smaller than the penetrant type and possesses no barb.

(3) **Glutinant** :

This is also a short process either coiled or straight having no barb.

Modes of operation

When the animalcule is irritated, the layer of protoplasm surrounding the sac squeezes out the nematocyst and the threadlike process is at once thrown out with its inside out Thus the barbs come out first and the prey is fixed by them when the thread penetrates the body of the prey. It liberates a fluid into the body of the prey which paralyses it completely Now, by means of the tentacles the prey is removed to the opening of the mouth.

The volvent type when thrown out, coils round the body of the prey and fixes it Next by means of the tentacles the prey is removed to its mouth

The third type, that is the glutinant one, when protrudes out and is thrown over the prey, it liberates some sticky substance on it so that the tentacles can manipulate to remove the prey to the mouth of hydra and no slipping takes place. This kind of nematocyst not only helps the animal for fixing the tentacles on its prey but also paves the path for locomotion of the animalcule.

Q. 3. *Draw and describe the genital organs of the Leech*

Ans. See Q. 3, Second Paper, 1942 and 1945.

Or,

Q. 3. *Describe the reproductive system of both the male and female Prawns.*

Ans. See Q. 4, Second Paper, 1946. Pg.- 134

Q. 4. *Describe the brain of teleostean fish.*

Ans. A teleostean brain presents almost all the parts of a vertebrate brain. It has the following parts :—

1. Fore-brain or **prosencephalon** representing the cerebral hemispheres Its roof is non-nervous but is covered by epithelial pallium-like choroid plexus. The floor is slightly raised and this part represents the corpus striatum having a transverse band of commissure. The olfactory lobe is associated with the anterior region of the fore-brain.

2 The next posterior part of the prosencephalon presents what is called **thalemoncephalon,** *i.e.,* **optic thalami** and is also called the **tween brain** The lateral aspects of the **thalemoncephalon** is thicker and represents the optic thalami. The roof and the floor is comparatively thinner From this floor the optic nerve takes its origin The optic nerves do not form a true chiasma, though they cross each other.

Here, dorsally the penial body grows and the floor hangs down ventrally to form the infundibulum. The inner cavity represents the third ventricle The infundibulum bears the hypophysis or the pituitary body In most teleosteans, behind the infundibulum appears a sac-like structure called succus vasculosus This is probably a sense-organ.

3. Posterior to this "tween-brain" is the **mid-brain or mesencephalon** which represents the two optic lobes directed dorsally. Ventrally however, it represents the cruracerebri.

4. The hindermost part of the brain is called the hind-brain or **metencephalon**. Its roof presents the cerebellum and it

is tongue-shaped covering a part of the medulla oblongata, th next posterior part. The presence of pons verolii here i hardly seen.

5. Next posteriorly the brain is continued with the medull oblongata or **myelencephalon** or **after-brain.** This is furthe continued posteriorly into what is called the **spinal cord** Almost all the cranial nerves take their origin from th myelencephalon.

Or,

Q. 4 *Describe the venous system of a Toad*

Ans See Q. 5, Second Paper, 1937.

Q. 5 *Draw and lebel the various parts of the pectoral girdl of a Toad.*

Ans See Q. 5, Second Paper, 1944

Or,

Q. 6 *Compare the urogenital systems of a male Guinea-pi with those of a female one*

Ans See Q. 6, Second Paper, 1947.

1952

FIRST PAPER

Q 1. *What is protoplasm? Describe briefly its physical and chemical properties. What are the different kinds of movements exhibited by it?*

Ans. For the First and Second Parts, see Ans. to Q. 1, First Paper, 1941.

Movements

Protoplasm, which is enclosed within a living cell of a biological unit, is always active and moves in a stream. This movement may be classed under two heads :

(*a*) **Rotatory** and (*b*) **Circulatory**.

(*a*) When protoplasm moves in a *definite direction* along the cell-wall of a biological unit round a vacuole, the movement is said to be a *rotatory* one. In Vallisneria or Hydrilla the movement of protoplasm as observed under microscope is one of rotation

(*b*) Sometimes protoplasm moves around small vacuoles in a cell *in different directions* and not *in a particular definite direction*. Such movements are known as *circulatory* *i e.*, circulation movement. Such movement can be found under microscope in the hairs of Tradescantia.

Q. 2 *What is a tissue? Enumerate the principal kinds of tissues found in plants Briefly describe their microscopic appearance with neat sketches*

Ans. A tissue is a collection of a number of cells arising from a single cell or a group of similar cells having a *common origin* and discharging the same duties.

Tissues can primarily be classified into two principal heads .

(1) **Meristematic** and (2) **Permanent**.

(1) Meristematic tissues have the property of continuous growth by repeated cell division. The cells of a meristematic tissue have thin walls and made up of cellulose substance having an elongated or rather polygonal shape.

(2). Permanent tissues grow out of meristematic tissues and perform special functions. These lose the power of cell division and reach a permanent structure. Its cell-wall may be found to be composed of cellulose, pectose and pecto-cellulose. The meristematic tissue may be classed as follows :—

- (1) *Primary*
  - (a) Apical
  - (b) Intercalary
- (2) *Secondary*

Permanent tissues may be classed as follows :—

- (a) *Cellular* :
  - (1) Prosenchymatous
  - (2) Sclerenchymatous
  - (3) Parenchymatous
    - (i) Thick walled
    - (ii) Thin walled
    - (iii) Collechymatous
- (b) *Vascular*
- (c) *Glandular*
- (d) *Laticiferous*

N.B. For the microscopic appearances of each of the tissues described above, see any text-book of Botany.

Q 3. *Give a brief account of the various devices by which seeds are dispersed. Cite familiar examples.*

Ans. Plants seek the changes of dispersing their seeds as widely as possible There are five means of doing so, in general (1) Explosion , (2) Wind dispersion ; (3) Water dispersion , (4) Bird dispersion , and (5) Burs.

(1) **By explosion**

Some fruits disperse the seeds from them by suddenly bursting and thus scattering their seeds wide away. In Shephalika Dopati and Amrool we find such dispersion.

(2) **By wind :**

The seeds that are dispersed by wind possess some adoptations by which they can float in air and are carried away by wind far away In Sajina, Madhabilata, Akanda, etc. there are special adoptations. Sajina and Madhabilata seeds are winged ; Akanda or Cotton seeds are provided with a crown of hairs which help them to float in air and thus they are carried away.

(3) **By water :**

Some fruits or seeds are carried away by water from one place to another. The seeds of the aquatic plants or cocoanuts have the devices of floating and thus they are carried away from place to place for dispersion.

(4) **By Birds or Animals :**

In such cases fruits are carried away by men and animals. *e g* , Mango, Peach, Guava, etc , are carried away by men to long distances and thus distribution of the seeds is made.

(5) **Burs :**

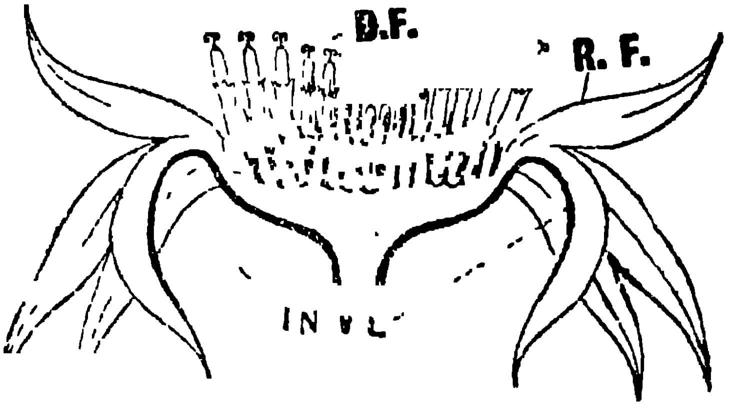
Some fruits and seeds are provided with sticky materials on their outer surfaces or spiny processes They mechanically adhere to the bodies of men or animals and thus they are carried away from place to place Chorekanta, Bena, etc. are carried away in like manner and thus they are dispersed far and wide

Q 4 *What is an Inflorescence ? Describe with sketches and examples the typical forms of simple racemose inflorescences.*

Ans A number of flowers may develop from a common stalk or **rachis** This whole system is called an **inflorescence.** A solitary flower may also constitute an inflorescence, if it is produced on a rachis.

Racemose type .

In this type of inflorescence the main axis continues to grow and the flowers open from base to apex in acropetal succession, according as they are developed Thus the first born flower opens first and the last born flower opens last. In sunflower or marigold or in mustard we note this system. Thus they stand for examples.



D F.—Disc. florets , R. F —Ray flo ets ; R. —Rachis ;
IN V L—Involucre of bracts

Q. 5. *Give a coincise account of the various kinds of induced movements in plants.*

Ans. Induced movements which is called irritability as observed in plants may be classified as :

(1) By light, (2) By force of gravity, (3) By the influence of moisture, (4) By contact; (5) By chemical substances; and (6) By change of temperature.

(1) **By light :**

If a plant be grown by the side of a window, the stem and the shoot are seen to bend towards light whereas the root away from the light. Thus stem or shoot shows positive heliotropic movement whereas the root shows negative heliotropic movement.

(2) **By gravity** .

Most plants when grown upon soil, the shoots grow straight upwards *i.e*, away from the centre of the earth but the root grows straight downwards, towards the centre of the earth. Thus in the former the **negative geotropic** movement is shown whereas in the latter positive geotropic movement is shown.

(3) **By moisture** :

Such induced movement is seen in the roots or root-hairs. They move in the soil towards moist places to take nutritive solution from it. Such a movement as exhibited by the roots or root-hairs is called **positive hydrotropic** movement.

(4) **By contact**

When some plants come in contact with a foreign substance, either the plants or the parts of the plants bend round the contact. Such contact movements are seen in stem climbers, tendril climbers or leaf climbers In mimosa pudica (লজ্জাবতী) the leaves droop downwards when they are touched.

(5) **By chemical substance** :

In Fern the matured spermatozoids are attracted by malic acid present in the matured archegonia Similarly, the matured spermatozoids of moss are induced by canesugar produced by the matured archegonia. Such movements are known as chemotropic movement

(6) **By change of temparature :**

Change of temperature affects the movements in many parts of a plant. This movement is called thermotropic The chlorophylls in the leaves move away from strong heat. The activity of protoplasm is greatly modified by temperature Too high a heat kills the protoplast as also too low a heat ; under optimum temperature however, a plant thrives most.

Some flowers such as Hasnahana, সন্ধ্যামণি etc. close during the day but open during night. Here both light and temperature affect the tropic or induced movement.

Q 6. *Describe briefly the difference between aerobic and anaerobic respiration Give an illustrated account of any experiment which would justify the belief that plants respire.*

Ans (*a*) Respiration may be of two kinds One is called aerobic and another anaerobic or intramolecular. In the former process a free supply of oxygen is obtained from the atmosphere but in the latter no necessity of the supply of oxygen from the atmosphere arises

In absence of oxygen or air some portions of the plant structure is broken down and oxygen is obtained from that decomposition and thus the plant respires Here the loss due to anaerobic respiration is more than that in aerobic respiration

In some cases, as in yeast, some enzyme is secreted which helps the decomposition of sugar liberating CO_2 and bringing about fermentation. This act is one due to anaerobic respiration.

(*b*) **That plants respire :**

See Ans to Q 6, of First Paper, 1935.

Q 7. *What do you understand by the term gametophyte ? Compare gametophytic generation of a moss with that of a fern.*

Ans. During sexual reproduction two specialised cells are seen to unite together. One is called the male unit and the other is called the female unit. The ultimate result of union of these two units is called either a zygospore or an oospore according as the two uniting cells are similar or dissimilar. This process is called gametophyte.

(*a*) *Gametophytic Stage in Fern* :

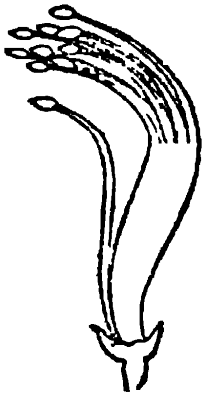
See Ans. to Q. 5, First Paper, 1935.

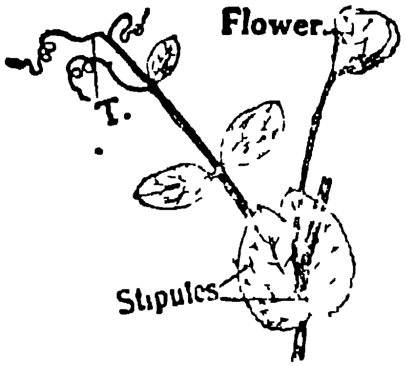
(*b*) *Gametophytic stage in Moss* :

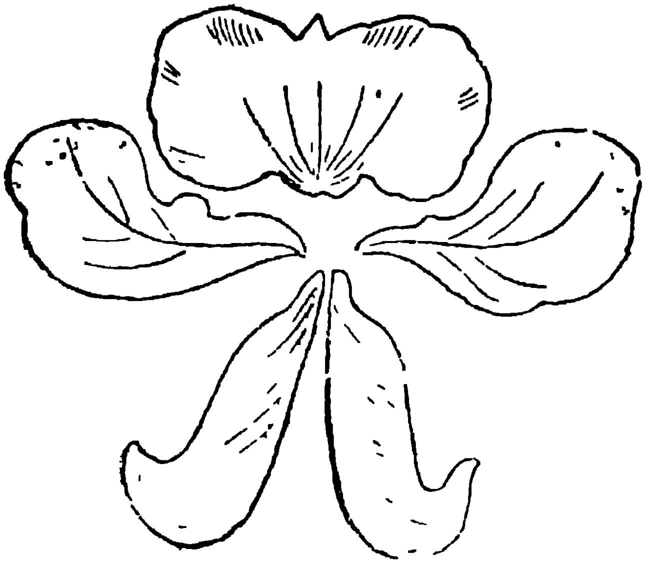
See Ans. to Q 6, First Paper, 1937.

Q 8. *Describe with sketches the external features of pea plants, showing vegetative and reproductive parts.*

Ans. The sketches are given below.







Q. 9. *Write notes on* :—

(*a*) *Pollination,* (*b*) *Nucleus,* (*c*) *Mutation.*

Ans. (*a*) **Pollination :**

It is a process of transference of a matured pollen grain from an anther to a matured stigma. This is brought about by various means : (*i*) by wind, (*ii*) by water, (*iii*) by insects, etc. Pollination may happen by the pollens of a particular flower with the stigma of the same flower or with the stigma of a different flower. The former is called *self-pollination* and the latter is called *cross-pollination.*

(*b*) **Nucleus** :

It is a specialised part of protoplasm in a biological cell. It plays a very important part in effecting cell-division. Hereditary characters are transmitted from generation to generation by nucleus It is bounded by a thin wall called nuclear membrane It contains nucleohyaloplasm, linins, chromatins, nucleoli and sometimes centrospheres. Nucleus is stained deep yellow by iodine solution as seen under microscope.

(*c*) **Mutation** :

A particular species of plants or animals hands over the specialities of its own heridity to each of the next generations, though each individual is different in various other respects but the inherent properties do not change. It is certain, of course, that the individuals of a particular generation differ from each other This variation is the law of nature and by this each individual fits itself with the natural environment. In some instances however, it is seen that some parts or other of a particular individual in a particular generation are quite different from the parents A kind of plant having a single-decked flower may produce a generation giving double-decked flower The petals of the flower in a particular generation may differ in the next generation This **sudden variation** from the parental characters is known as mutation. A birth of a monster in a human being is a mutation.

SECOND PAPER

Q. 1. *What is the difference between a germ cell and a somatic cell ? Describe the stages in a mitotic division.*

Ans When a male gamete unites with a female gamete, the union called fertilization, produces what is called a **zygote**. This zygote after repeated divisions gives rise to a particular animal. During this division a few cells are set apart for the purpose of carrying on the function of reproduction in this generation. These particular cells are called **germ cells** and the rest of the cells that go to form the body of the animal are called **somatic cells**. Thus germ cells are special cells for the development of the particular cells for reproduction only and carry on the inherent peculiarities of the parents from one generation to the other.

The different stages in mitotic division are four in number. Here the nucleus of the parent cell divides into two daughter nuclei followed by the division of the cytoplasm of the cell. Thus as a result of this division two cells develop out of one.

The stages are ·

(1) **Prophase** , (2) **Metaphase** , (3) **Anaphase** , **Telophase.**

(1) **Prophase**

In this stage the nucleus is seen to consist of some distinct thread-like bodies called chromosomes These chromosomes never come together Thus the primary nucleus disappears.

(2) **Metaphase** :

Next the nuclear membrane disappears Spindle appears and the centrosomes, each, after dividing into two, arrange themselves along the two poles of the spindle. The chromosomes also now arrange themselves along the equatorial plane of the spindle.

(3) **Anaphase**

Now the anaphase begins. The spindle elongates in the middle forming what is called a **stem body**. The chromatids also separate At both ends of the spindle all chromosomes collect in equal number forming two sets or groups, one set just corresponding the other.

(4) **Telophase** :

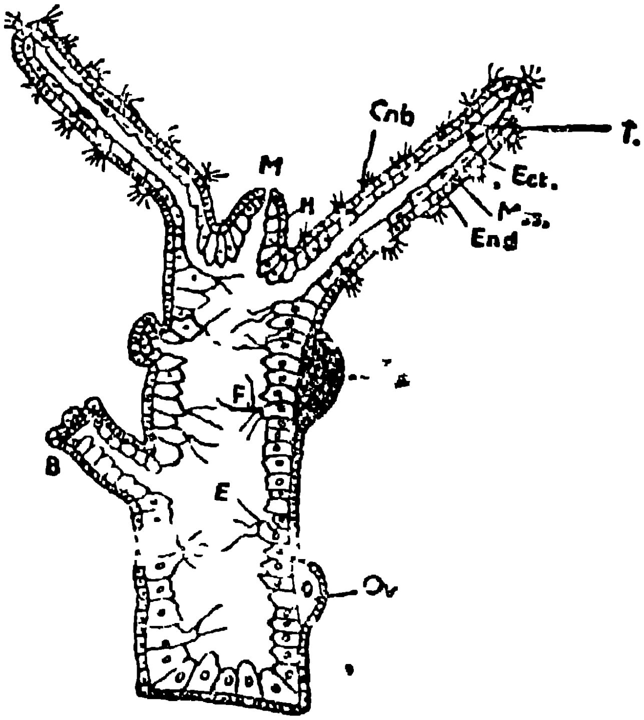
This is the last stage. Here a new membrane appears round each group of chromosomes. The chromosomes become straightened and no more coiled. A constriction now begins to appear along the central plane of the original parent cell which gradually deepens and ultimately divides the parent cell into two resting cells.

Q. 2. *Describe the life history of Monocystis.*

Ans. See Ans. to Q. 2, Second Paper, 1935

Q 3. *Describe the reproductive system of Hydra.*

Ans Hydra is usually hermaphrodite. Both male and female generative organs are formed in the body of the same animal. The testes or the spermaries are produced earlier than the ovaries The testes are small swellings and are developed at the upper part towards the free end. The number of the testes are found to be from 4 to 20 in each individual. They are developed from the interstitial cells, and the epithelio-muscular cells are pushed out to form a swelling. These divide and spermatozoa are developed. Each spermatozoon has a nucleus and a vibratile tail These come out by breaking off the surface layer, i e., the ectoderm and the cuticle move about for a short time in water.



(SP—Spermary or testis , OV—ovary).

Ovaries are found towards the base of an individual. The interstitial cells multiply and thus a swelling appears to come pushing out the epitheliomuscular cells One of the interstitial cells grows out at the cost of its neighbouring cells which are absorbed by the pseudopodia and thus it forms what is called the **oocyte** or **ovum.** Within this ovum spherical grounds of yolk are formed in the cytoplasm When the ovum or the oocyte matures, the musculo-epithelial cells are broken and the ovum protrudes out and are thus exposed Anv spermatozoon swimming in the water finds its way into this ovum and fertilization takes place.

Q 4. *Give an account of the excretory organs in the Leech.*

Ans. Extretory organs in leech consists mainly of the seventeen pairs of **Nephridia** The first nephridium lies in the 7th segment of the animal and the last lies in the 23rd segment.

These open laterally in the ventral surface of the animal through which the waste products and excess of water in the body are excreted out.

Each nephridium consists of two different parts :

(1) The main mass or lobe of the nephridium consists of a horse-shoe-shaped lobe and is glandular in structure. This part carries out the proper excretory function (2) The next part of the nephridium consists of a vesicular or bladder-like body which is internally ciliated and this opens to the exterior. This bladder or vesicle contains some white fluid and waste crystals.

N B Nephridia are seen surrounded by blood vessels and waste products are extracted from the blood vessels. These waste products are thrown into the nephridia The horse-shoe-shaped part of each nephridium collects these waste products and excretes out to the exterior by means of the vesicular portion.

✓**Q 5.** *How do the prawn and the fish swimming in water maintain their balance and perceive direction of motion ?*

Ans.

Prawn :

The maintenance of balance and perception of the direction of motion are done by a special sense-organ called statocyst or otocyst in prawn.

In each prawn there are two otocysts. They are found in the basal segment of each of the 1st antenna on each side. Each statocyst is fully innervated and is connected to its antenna

It is round or oval in shape and thus it is a closed chamber having an external opening covered by small bristles. Within it is a gelatinous fluid and also some **otoliths** or sand grains. There are some hairs grown around these foreign grains curled towards the centre While the animal moves about these hairs touch the grains and produces sensation of position, direction and balance as semicircular canals act in vertebrates

Fish :

In fish however, the power of orientation is functioned by the lateral line sense organs This line has an intimate connection with the lateral line nerve fibres derived from the vagus The sensitiveness to touch, etc , is also developed in the head Fish has no definite ears, as these are deeply buried, still it appears to hear Thus this structure also helps in the movement and balance.

Q 6 *Describe the structure of the vertebral column in Frog or Toad, mentioning the types of the vertebrae found.*

Ans. The vertebral column of a toad consists of nine vertebra and a urostyle.

Since the first vertebra called the *Atlas* articulates with the skull, it has two facts for the two condyles of the skull and an odontoid lying in between the two condyles. It has no transverse process

The last vertebra, *i e* , the ninth one may be called a sacral vertebra, since it articulates with the hip or pelvic girdle.

Each vertebra has the following parts to note :—

(1) Its body—called centrum.

(2) An arch—called neural arch above the centrum so as to form a ring round the spinal cord.

(3) The hollow of each vertebra is its neural canal and also may be called the **Vertebral foramen**.

(4) The roof of the arch is raised and forms a low ridge and this is called the **neural spine**

(5) From either side of each vertebra one process projects laterally called the **transverse process** These are the longest on the last or sacral vertebra.

(6) Both anteriorly and posteriorly are the articular processes, one on each part and each of it is called **zygapophysis** or the articular process.

(7) The post zygapophysis is absent in the 9th vertebra. There are two condyler facets to be articulated with the urostyle.

(8) The urostyle which is a structure formed of several vertebrae being fused together presents dorsally a **narrow** median ridge

Q 7. *Describe the course of circulation of blood in a fish.*

Ans

(1) The impure blood from all parts of the body of a fish collects in the **Sinus Venosus**

(2) This opens into a thin-walled **Auricle**.

(3) Next it passes to the thick-walled **Ventricle**

(4) Now it reaches the structure called **Bulbous Aorta**.

(5) This by its contruction drives the blood into the **Ventral Aorta**.

(6) From this aorta *four* afferent branchial vessels arise on each side and enter the gills Here the blood is purified.

(7) This purified blood now passes through the efferent branchial vessels and form four such vessels on each side. The further route of the blood :—

(8) The 1st and 2nd efferents on each side form an **Anterior Epibranchial** artery.

(9) The two anterior epibranchials on both sides form what is known as **Dorsal Aorta.**

(10) The 3rd and 4th efferents form the posterior epibranchial on each side and ultimately join the dorsal aorta.

(11) The dorsal aorta has the following branches :

(*a*) Two subclavian, one on each side.

(*b*) One, called coeliac artery supplying the intestines and liver.

(*c*) One superior mesenteric supplying the intestines, pancreas and spleen.

(*d*) Two branches to the reproductive organs.

(*e*) A part to the rectum.

(*f*) Two renal arteries supplying the two kidneys.

(*g*) The last to the pelvic fins.

(12) At each end of the sinus venosus there is one precaval sinus which receives the venous blood from all parts of the body together with the blood coming from the **renal portal** and **hepatic portal** and ultimately this blood finds its way into the sinus venosus again

Thus the circulation of blood is maintained in a fish.

Q 8 *Show in what way the brain of the Guinea-pig differs from that of the Frog or the Toad.*

Ans. The two brains, one of guinea-pig and the other of toad present essentially all the principal divisions , but the brain of the guinea-pig is more developed and is placed on a higher grade than that of the brain of the toad Though each brain is divisible into five different parts, still when studied in details the brain of the guinea pig gives us various greater complexities than those in the brain of the toad. Each of the brains deserves separate considerations wherefrom the proper comparison might be drawn and studied

Guinea-pig brain ·

It presents the following parts :—

(1) Cerebral hemispheres, (2) Optic thalami, (3) Optic lobes, (4) Cerebellum and (5) Medulla oblongata.

There are two membranous coverings on the brain and below the cranium. The outer one is tough and membranous, called *Dura mater* and the inner, *i.e.*, the layer just in contact

with the brain is called *Pia mater* and very vascular. In guinea-pig there are twelve pairs of cranial nerves.

(1) The cerebral hemispheres appear conical in shape. The narrow portion projects anteriorly and the broad portion, *i.e.*, the base posteriorly. The basal part, covers the optic thalami and the optic lobes. The surface of these hemispheres presents some convolutions with depressions called *Sulci*. Thus it is divisible into the following lobes :

(*a*) Frontal, (*b*) Parietal, (*c*) Temporal and (4) Occipital

These two hemispheres are connected by a broad bridge called corpus callosum and also a longitudinal band, called *fornix.* At the anterior end of each of the hemispheres is the olfactory lobe or olfactory bulb There is another transverse band below the lateral ventricles, called *corpus striatum*

(2) The next posterior part of the brain, *i e*, the thalemoncephalon remains covered by the broad bases of the hemispheres Here the *pineal* body is seen dorsally and the infundibulum is seen ventrally On the front part of the thalemoncephalon lies the *corpus geniculatum*, one on each side. Dorsally and in front of the infundibulum is the *optic chiasma*

(3) The optic lobes are divided into four segments and form what is known as *corpora quadrigemina.*

(4) Next comes the *cerebellum* The two sides of this are connected ventrally by Pons Varolii lying over the medulla.

The cerebral hemispheres and the cerebellum contain cavities and these are called the ventricles Dorsally is bound by the choroid plexus covering the roof of the fourth ventricle

(5) Posterior to the cerebellum and below it lies the medulla oblongata which is continued with the spinal cord further posteriorly On the ventral surface of the medulla is found a deep fissure bounded by two narrow bands called *pyramids*

Toad-brain

This is simpler than guinea-pig brain This also presents the five different parts but in details it is less developed. It is covered by a darkly pigmented membrane called *Pia mater* only. The parts are : (1) Two cerebral hemispheres, (2) Thalemoncephalon, (3) Optic lobes, (4) Cerebellum and (5) Medulla oblongata In toad there are ten pairs of cranial nerves and not twelve pairs, as in guinea-pig.

(1) The elongated two cerebral hemispheres have one *olfactory lobe* at each anterior end. These two hemispheres are connected by two commissures : one is anterior and the other is posterior There is no true cropus calosum

(2) Next comes the thalamoncephalon which bears the *pineal body* dorsally and ventrally there lies the *chiasma. A rudimentary tongue-shaped* mass is seen here, called the *infundibulum* The cavity of the thalamoncephalon is the third ventricle which is again continuous with the ventricle.

(3) Posterior to the thalamoncephalon are the two oval bodies called the optic lobes

(4) Next posterior to this is the cerebellum This is represented by a transverse band and not so well-developed as in guinea-pig

(5) Last and most posterior part of the brain or the 5th part is the medulla oblongata Its roof is covered by Pia mater membrane forming the vascular choroid plexus, within this lies the fourth ventricle which is continuous in front with the 3rd ventricle which in turn, is continuous in front with the *foramen of Monro* and this foramen is connected on either side with the 1st and 2nd ventricle lying within the cerebral hemispheres

Q 9 *State evidences of the theory of organic evolution*

Ans See Ans to Q 7, Second Paper, 1935, and Q. 7, Second Paper, 1936

Q 10 *Write notes on the following* :—

(i) *Connective tissue*, (ii) *retina*, (iii) *contractile vacuole*, (iv) *maxilliped and* (v) *gastrula.*

Ans

(i) Connective tissue :

This tissue is developed from the middle layer or the mesoderm of the embryo. It is characterised by great preponderence of the intercellular substance. During the first stage of development it consists of cells only and later on fibres are *developed. General functions are to bind, to connect and to support.* The connective tissue is differentiated into *connective tissue proper, cartilage* and *bone.* Blood is a fluid connective tissue.

(*ii*) **Retina :**

See Ans. to Q. 7 (*f*), Second Paper, 1940.

(*iii*) **Contractile vacuole ,**

See Ans. to Q 7 (*a*), Second Paper, 1940

(*iv*) **Maxilliped :**

Of the thoracic appendages of prawn the first three pairs are called maxillipeds and the other five are the legs These three pairs of maxillipeds are so adopted as to catch the preys and thus act like jaws These possess distinct exopodites but the legs in adult prawn have lost them.

(*v*) **Gastrula :**

When an embryo develops from an egg, especially in homolecithal egg, after passing through the *Morula* and *Blastula* stages, successively the third stage of Gastrula comes. Just before this stage begins the embryo, consists of a hollow or solid ball-like body having one layer of cells on the surface with a "segmentation cavity" within The outermost layer of cells is called the *blastoderm* and the segmentation cavity, if present, is called the *blastocoele*

Now from one layer of cells two layers are formed The outer layer is called the **epiblastic** or **ectodermic** layer and the inner layer is called the **hypoblastic** or **endodermic** layer.

The upper part of the embryonic cell containing one layer of cells begins to grow more rapidly and the lower part appears dipped or dimpled inside the cavity invaginating the upper layer and thereby the blastocoele gradually disappears. The lower row of cells gradually reaches the inner border of the upper cells and thus a two-layered cell is formed. The outer layer forms the ectoderm and appears convex and the inner layer, which obliterates the blastocoele is called the endoderm and appears concave. This stage is the stage of gastrula and the process is gastrulation This sort of double layer formation may be brought about either by gastrulation or by *délamination.*

1953

FIRST PAPER

Q 1. *Describe with sketches the structure of the flower of pea plant and mention briefly the functions of its different parts.*

Ans. For the answer of the First Part See Ans. to Q. 6, First Paper of 1941.

Functions of different parts :

Calyx

The main function of the calyx is protection of the other floral members of the flower during bud

Corolla

These serve the purpose of attracting bees or insects for the purpose of pollination and hence the petals are often coloured.

Androecium :

It is the male reproductive whorl of the flower producing pollen grains. Special function being that when the bee visits the flower for honey on the keel of the flower, the matured androecium dusts the pollen grains on the body of the insect. This it carries to other flowers when visiting them and pollinates the stigma of the second flower Thus cross-pollination is carried

Gynæcium

This is the female reproductive whorl It receives the pollen grains on its sticky stigma from the bee that visits the second flower and ultimately fertilization takes place producing the fruit.

Or,

What is venation? Describe with sketches the principal forms with reference to Indian plants as examples What are the functions of the veins

What is venation ? For Ans See Ans to Q 7 (e), **First Paper of 1939.**

For sketches—See diagram in any text book. For forms and examples see below

The most common forms of venations are two. These two types may be further classified

Venation

Reticulate or Net-like venation
Parallel venation

Pinnate or unicostate
Palmate or multicostate
Pinnate
Palmate

Pinnately Reticulate Here the veins ramify repeatedly over the leaf surface forming a network over the surface of the leaves *e g*, Aswatha leaf, Mango leaf, etc

Palmately Reticulate As in gourd or papaw Here the principal vein *i e*, the midrib branches right and left which still more branches in the similar way over the whole surface of the leaf

Pinnately parallel As in Banana Here there is a strong midrib and a number of parallel veins from the midrib runs along the whole surface of the leaves. In bamboo or grass leaves, there is no distinct midrib but all the veins run parallel to one another from the base of the leaves These can be called *palmately parallel* veins.

Functions The main functions of the veins are to conduct the raw food materials drawn up by the roots to the leaf surface for elaborate metabolism on the surface of the leaves When the raw food materials are transformed into prepared food materials, they are transported to the different parts of the plant.

The veins also afford mechanical help in keeping up the shape and form of the leaf and thus save it from the climatic disturbances.

Q. 2. *Describe fully with a labelled sketch the internal structure in transverse section of a typical dicotyledonous stem at the commencement of secondary growth.*

During the commencement of secondary growth in a dicotyledonous stem the cambium layers lying in the bundles, called **fascicular** cambium, gets meristematic activity and adds xylem elements towards the central part of the stem and phloem elements towards the peripheral part of it.

Now, some of the cells of the **primary medullary rays** become also meristematic in the meantime By their repeated divisions new cambial layers are formed in between the bundles These cambial layers are called **interfascicular cambium** Gradually, however, these two types of cambiums join each other and a cambial ring is formed

Fascicular cambium layer produces new groups of secondary phloem and xylem and also some radial bands of parenchymatous cells within the spaces of the newly formed bundles. These are called the secondary medullary rays. These do not extend up to the pith of the stem as the primary ones

The interfascicular cambium in the meantime begins to produce new types of xylem and phloem and also some parenchymatous cells which soon join the primary medullary rays. In this way a continuous growth in thickness of the stem comes in.

Secondary phloem consists of hard bast, sieve-tubes, companion cells, bast fibres and phloem parenchyma.

Secondary xylem has pitted vessels, trachieds, wood fibres and xylem parenchyma

Or,

What are 'starch' and 'aleurone' grains Describe their structure with sketches How would you demonstrate their presence in the plant tissues ? What kind of food do they represent ?

Ans.

Starch :

It is, chemically, a carbohydrate containing carbon, hydrogen and oxygen The last two elements are present in the proportion in which it is present in water i e , H · O . 2 1 by atoms. The chemical formula of starch is $(C_6H_{10}O_5)n$.

When a microscopic section of potato **is** examined under high power a dark spot called hilum is seen **at** one end of **each** granule This hilum is concentrically or excentrically surrounded by five refractive lines or layers, called stratification Starch grains mav be simple or compound and of various forms The forms in potato are oval but in wheat they are round and in Manasa or Varenda they are seen dumbell-shaped. The starch grains are stained blue by iodine. This is the micro-chemical test for the compound

Thus starch represents carbohydrate class of food in plants stored up in them for future use

Aleurone ·

These are present in a large number of seeds as in castor oil seed, in pulses, and in wheat etc They are seen in small grains and are proteid in nature *i e* nitrogenous compound When a microscopical section of castor oil seed is examined under high power the aleurone grains are seen in crystalline forms, called crystalloids In wheat the aleurone grains are not of crystalline forms

Aleurone grains are coloured brown or yellow with iodine and yellow with very dilute nitric acid as seen under the microscope

Thus aleurone grains represent the nitrogenous food of plants

N B In castor oil seed apart from the crystalline forms of aleurone grains some round masses are seen lying on one side of the crystalline body and these are called globoids These globoids have different chemical composition from that of the aleurone grains These globoids are a double phosphate of calcium and magnesium. In other cereals however globoids are not present though aleurone grains are seen

Q 3 *What chemical elements are essential for the normal growth of a green plant? Explain the process by which these are absorbed*

Ans For Ans See Ans to Q 1, First Paper 1947 and Ans to Q. 5, First Paper of 1950

Or,

By what path does water travel up the stem of a tree? What do you know of the forces which cause the upward flow?

Ans The paths through which water travels up the stem of a tree are its xylem vessels.

The unicellular root hairs absorb the nutrient solution from the soil and gradually inside pressure increases and the root hairs become turgid In virtue of their being turgid, they set up a pressure to the cortical cells which in turn receive the liquid from the root hairs endosmotically and become turgid. This turgidity of the cortical tissue of the plant sends its water into the adjoining xylem vessels and becomes less turgid and collapses. Again this cortical tissue gets more water from the root hairs and regain the turgidity when a fresh supply of water is made into the xylem vessels Thus a sort of pumping action goes on from the cortical tissue to the xylem vessels

The xylem vessels having their fine bores exert a capillary action also whereby more suction goes on These two forces namely, the turgidity of the cortical cells and the capillarity of the xylem vessels, create what is known as **root pressure**

In addition to the root pressure the process of transpiration from the leaves sets up another suction force by means of which water ascends the plant stem through the xylem vessels and ultimately reaches the leaves

Thus the forces that cause the upward flow of water from the soil to the leaves of the plant are (1) turgidity (2) capillarity and (3) transpiration

Q 4 *What is a Saprophyte? Carefully compare and contrast the spore-bearing generations in Moss and Fern plants Give neat sketches*

Ans For Ans See Q 5, I, 1944, Q 6, I, 1947, and Q 4, I, 1950

Saprophytes are plants that grow in humid soil and derive their food from decaying or rotten organic matters These do not possess any chlorophyll and thus cannot prepare their own food *e g.*, mucor, mushroom, yeast etc Also See Ans. to Q 7 (*a*), First Paper of 1947.

For comparing the spóre-bearing generation in Moss and Fern

(*a*) For Fern See Ans to Q. 5, First Paper of 1944 and Q 4, First Paper of 1950

(*b*) For Moss See Ans to Q. 6, First Paper of 1947.

Or,

Compare yeast spirogyra, Moss, Fern and pea-plants in form and external structure and show how these plants exhibit different degrees of differentiation of the plant body. Give illustrative sketches

Ans Yeast, Spirogyra, Moss and Fern, represent the Cryptogamic division or they can be called spore plants The last one, *i e*, the pea-plant represents the phanerogamic division

Yeast

It is a unicellular non-green thalophytic plant It is oval shaped in form It cannot prepare its own food and has got to depend upon organic matters for nutrition, growth and reproduction and hence it falls under the class of saprophyte

Spirogyra :

It is a non-branched, green filamentous aquatic plant. It can prepare its own food in virtue of its containing chlorophylls It consists of cylindrical cells joined end to end and thus represents a filament-like structure It is a green algæ representing a thallus body *i e*, no differentiation of root or shoot The gametophytic stage is more prominent in this plant.

Moss

This plant stands on a higher level than Yeast or Spirogyra in having a differentiation in stems and leaves. True roots are absent but having root-like structures called Rhizoids. This plant is able to prepare its own food in having chlorophylls present in them The gametophytic stage is more prominent than the Sporophytic stage.

Fern :

Fern plant stands on still a higher level than that of Moss. A considerable differentiation in tissues is seen. It has prominent vascular tissues It has prominent root, stem and leaves.

It prepares its own food In fern the sporophytic stage is more prominent than the gametophytic stage, the latter being small and not well developed This plant has true roots, well developed stem and leaves

N B. *Thus the above 3 types of plants fall under the division known as Cryptogamia or flowerless plants The first type is a thalophyte the second one is a bryophyte and the third one is pteridophyte*

Pea-plant ·

It is a herbaceous annual plant having a tap root and trailing stem with stipulate pinnately compound leaves The terminal leaflet is turned into a tendril by means of which the plant can climb

The flowers are seen in infloresecence of racemose type. Each flower has all the parts *i e*, the flower is bisexual and complete but irregular The fruits are legumes with round shaped seeds in them Each seed contains embryo *Thus this plant represents the division called phanerogamia or seed plant i e, spermatophyte*

Q 5 *Write short notes with sketches and examples on any five of the following —*

(a) Caryopsis, (b) Legume, (c) Spikelet (d) Pollen grain, (e) Embryo sac (f) Pericycle, (g) Stoma, · *(h) Chromatophore, (i) Prothallus, (j) Grand period of growth*

(*a*) **Caryopsis**

It is a simple fruit having a thin and membranous pericarp which is adherent with the seed. It falls under the class of dry indehiscent fruit, *e g*, Paddy, wheat, grass, *etc*

(*b*) **Legume** .

It is a dry type of simple fruit dehiscing by both sutures. The seeds remain attached to the ventral surface *e g*, Pea, Chhola Barbati, Bak etc. See Ans to Q 7 (*b*) first paper of 1943

(*c*) **Spikelet**

For Ans see Ans to Q 7 first paper, 1938.

(*d*) **Pollen grains** ·

Pollen grain is a spore box of male generative gamete It is a single cell of microscopic size having two coatings The outer coating is called extine, and the inner one called intine. The former coating is hard and the latter one is thin and soft. Pollen grains are formed within the pollen sac, the anther

(*e*) **Embryo Sac :**

From the placenta, in an ovary, grows an ovule Each ovule is protected by two layers of integuments The central mass of tissue is called the Nucleus The integuements leave a small opening, called micropyle , within the nucleus there is a large cell within the wall and this is called the embryo sac

(*f*) **Pericycle :**

When a transverse section of a dicot stem is seen under microscope, the most external layer of tissue is the epidermis, the next layer of tissue is called cortex, the third inner layer is endodermis and the next *i e* , the fourth layer of tissue consists of thin walled rectangular cells and is called the pericycle This layer stands just outside the vascular bundles Thus the vascular bundles form the next inner layer from the pericycle

(*g*) **Stoma :**

For Ans see Ans to Q 7 (*d*), first paper of 1942

(*h*) **Chromatophore** ·

Chromatophores are formed of a substance called plastids. When very young they appear as small *colourless* highly refractive bodies principally located round the nucleus. Gradually however, they may attain a further development forming any or many of the following

(*a*) Chloroplasts – When green in colour
(*b*) Chromoplasts When coloured otherwise than green
(*c*) Leucoplasts—When no colour develops on them

Thus chromatophores in a sense are pigment bearers See Ans to Q 2, first paper, 1945.

(*i*) **Prothallus**

For Ans see Ans to Q. 5, first paper of 1938.

(*j*) **Grand period of growth**

In a growing member for plants if the rate of growth is observed it is seen varying. At first the growth is not very vigorous but next it grows at a high rate, next again the rate of growth falls

The time occupied by this varying rates of growth is called the grand period of growth

SECOND PAPER

Q 1 *Describe the various structures found in the body of an amœba and mention their functions in each case*

Ans For Ans see Ans to Q 1 Second paper, 1944 Page 3

Or.

Compare and contrast segmentations of the body of the leech with that of a prawn

Segmentations compared and contrasted

BODY OF A LEECH	BODY OF A PRAWN
1 Number of Segmentation is 33	1 Number of segmentation is 19.
2 Seven segments are fused posteriorly to form the posterior or hind sucker	2. Thirteen segments are fused together anteriorly to form cephalothorax
3 The segments are not movable	3 The segments are movable over one another.
4 The last segment forms a part of the hind sucker.	4 The last segment is attached to a hard conical and pointed structure called the **telson**
5 The body segments are covered by skin and no definite exoskeleton is present.	5 The body segments are covered by hard cuticular covering Thus exoskeleton is present

BODY OF A LEECH (*Cont.*)	BODY OF A PRAWN (*Cont.*)
6 The body segments are covered by skin	6. The body segments are covered by (i) Sclerites (ii) Each successive sclerite is joined with its fellow by **arthrodial membrane**
7. No lateral appendages are seen from the segments	7 One pair of appendage laterally from each of the segments are seen
8 No covering over head or thorax	8 The cephalothorax is covered by a single sclerite above and laterally, called carapace which has the rostrum anteriorly
9 Each segment or Somite in the middle portion of the body bears 5 rings or annulae. The number of rings however varies anteriorly and posteriorly Altogether there are 102 ring placed transversely on the body	9 The segments of prawn do not bear any ring and this is absent here

Q. 2 *Can the fish hear ? Give an account of the structure of the ear of the fish*

Ans. Yes, *a few* fish can hear They have got ears and auditory functions are present in them. The external ear is not present but the internal ear is present.

The structure of ear in fish is not so complicated as in higher mammals The auditory cavity of the internal ear is formed by five bones on each lateral aspect of the skull, each being called an otic bone They are (i) Epiotic, (ii) Opisthotic, (iii) Prootic, (iv) Pterotic and (v) Sphenotic. These are placed just in front of the ex occipital bones.

There is no drum but semi-circular canals are present. The semi-circular canals are 3 in number An otolith is always found in the labyrinth Here a knob like structure is seen which represents the cochlea Thus the cochlea is not well developed

The exact situations of the otic bones are as follows

(i) Epiotic—This lies behind the parietal bone.

(ii) Opisthotic—This is just posterior to the prootic bone.

(iii) Prootic—This is situated below the pterotic and sphenotic

(iv) Pterotic—This is by the side of the parietal and articulates with hyomandibular

(v) Sphenotic lies by the respective side of the frontal and anterior to the pterotic

Or,

Ans For Ans see Ans to Q 3, second paper of 1947

Q 3 *How do you distinguish the skull of the toad from that of the guinea pig ?*

Ans Distinction between a toad skull and a guinea-pig skull

TOAD SKULL	GUINEAPIG SKULL
1 It is lighter	1 It is weightier.
2 It is smaller in size	2 It is bigger in size
3 It is flat in shape	3 It is roundish in shape.
4 There is no bony sutures	4. There are bony sutures
5 Comparatively the orbital cavity is bigger	5 Comparatively the orbital cavity is smaller
6 All bones are thin and weak	6 Bones are thick and strong
7 Membrane bones are prominent	7. Osseous bones are prominent together with cartilage bones, and Membrane bones are few.
8 The dorsal surface of the skull is flat from side to side or antero-posteriorly.	8. The dorsal surface is convex, both ways.

TOAD SKULL (*Cont*)	GUINEAPIG SKULL (*Cont.*)
9. The lower jaw does not articulate with the skull.	9. The lower jaw articulates with the skull.
10. The angular process of the lower jaw is absent	10. The angular process of the lower jaw is prominent.
11. No distinct tympanic bone nor the tympanic bulla.	11. Distinct tympanic bone and tympanic bulla.
12. Jaws are toothless	12 Jaws bear teeth.
13. Pre-maxilla is toothless.	13. Pre-maxilla bears incisor teeth
14. No bony palate.	14 It has bony palate
15 No ear ossicles	15 There are three ossicles of each ear

Or,

Describe the origin, course and distribution of the V and the X cranial nerves in the toad or frog.

Ans **Fifth nerve**

It is the trigeminal nerve. It takes its origin from the anterior part of medulla oblongata. It has three branches They are distributed as below :

1. The **opthalmic** branch is distributed to snout and the skin over it
2. The **maxillary** branch is distributed over the upper jaw.
3. The **mandibular** branch supplies the lower jaw.

Tenth nerve

It is the vagus or pneumogastric nerve. It takes its origin from the side of the medulla oblongata. It supplies larynx, lungs, heart and gut Thus it has several branches as below :

1. **Laryngeal branch**—Supplying and hence distributed over the larynx
2. **Pulmonary**—Being distributed over the lungs.
3. **Cardiac**—Being distributed over the heart.
4. **Gastric**—Branch supply the stomach and some parts of the intestines.

Q 4 *Give an account of the formation of amnion in the chick embryo.*

Ans For Ans See Ans to Q. 3. Second Paper, 1948.

During the development of chick embryo, the blastoderm extend and covers the yolk Here the blastoderm might be divided into two layers, one, the embryonic and the other extra-embryonic Next during the symmetrical extensions of the ecto- and endoderms, mesoderm also proliferates posteriorly and laterally, and next it comes forward in paired layers. Now the blastoderm which is composed of ectoderm and endoderm, comes forward in front of the embryo and forms what is called the '**Pro-amnion**"

The amnion however, appears just before the embryo is "folding off" from the yolk This consists of two membranes.

The curved fold arising in front of the head of the embryo is called the **amniotic** fold and grows from the proamnion. This layer consists mainly of ectoderm By this time mesoderm just begins to grow for the proamnion This fold rapidly passes backwards while another such fold appears round the tail end Thus it is a fold of **Somatopleure**

Gradually the amniotic fold closes above the embryo and a double layered membrane is formed just like a dome over the embryo The inner layer of the folding membrane consists of ectoderm and the outer layer consists of the mesoderm. This is the amnion proper A cavity is enclosed by the membranes called the amniotic cavity This cavity becomes filled with a liquid called **amniotic fluid** It helps the embryo in forming a cushion-like bed and thus protects it from any resistance during its further growth.

The outer layer called the false amnion consists of ectoderm externally and mesoderm internally It is thus a serous membrane It fuses with the vitelline membrane at last and it lies below the membrane.

Or,

Explain the evidences of evolution either from morphology or from embryology.

Ans For Ans See Ans. to Q 1, Second Paper 1943 and Q. 7, Second Paper, 1948.

Q 5 *Distinguish between the following (a) the trophozoite and the sporozoite, (b) mesoglea and mesoderm, (c) the renal portal vein and the renal vein.*

Ans.

(*a*) **Trophozoit**

It is the full-grown unicellular animal such as in monocystis This is the adult stage of the animalcule It is eliptical in shaped One end is broader than the other bounded by a cuticular cell wall containing granular endoplasm surrounded by ectoplasm which forms the outer layer There is a nucleus in the endoplasm having a nucleus within it. There is no contractile vacuole in the body cell

Sporozoit

After reproduction, monocystis forms what is called some pairs of zygotes by the union and fusion of the gametes Each zygote gives rise to a spore which later on, transforms into pseudonavicella. After repeated division of the nucleus in each, eight new nuclei are formed Next the cytoplasm collects round each of the nuclei forming eight sickle-shaped bodies within the spore case At this stage each sickle-shaped body is called a sporozoit and it is ready to be transmitted to another host (earthworm) and thus completes its life-cycle Hence this is the final stage of the result of reproduction from which the adult animal stage or the trophozoit stage starts again in the second host

(*b*) **Messoglœa :**

It is a jelly-like cementing and non-cellular tissue formed in between the two layers of the body wall in a cœlenteron, *e g*, in Hydra It has no particular structure of its own. In it are found some ecto- and endodermic cells together with some nerve cells

Mesoderm :

It is an intermediate tissue between the ectoderm and the endoderm during the development of an embryo This is one of the three primary germ layers found to develop in an embryo.

During embryonic development a cavity called cœlom appears in the mesoderm. Thus the cœlom is lined by two kinds of mesoderm. The layer towards the ectoderm is called the somatic mesoderm and that towards the endoderm is called the visceral mesoderm.

(c) Renal portal vein :

This is a system of veins, as it is called. There are two such sets on two sides. This system is formed by the posterior branch of the femoral vein coming from the hind limb and before entering into the kidney on each side, receives the sciatic Vein, coming from the back of the hind limb and another vein called the dorsolumber vein draining blood from the dorsal and lumber portion of the body wall. These three veins unite and form what is known as the renal-portal system. In females, however, the oviduct vein also joins this system. Thus the renal portal system is formed. Thus the venous blood from the posterior region goes to heart via kidney on each side.

Renal Vein

The blood that circulates in the two kidneys, after passing through the capillaries, comes out of the kidneys through a vein called the renal vein and joins the post caval vein on either side from each kidney and thus the impure blood passes through the post caval vein to the heart to be purified.

1954

FIRST PAPER

Q 1. *Briefly describe the process of fertilization in an Angiosperm. Give neat sketches.*

Ans. For Ans. See *Ans.* to Q. 5 of 1947 First Paper ; also see *Ans* to Q. 4 of 1948, First Paper Page 157

Or, What is cross pollination ? How is it effected ?

Ans. Cross pollination :

For Ans see *Ans.* to Q. 9 (*a*) of 1952, First Paper.

How effected :

In cross pollination the pollen grains of one flower are transferred to the stigma of another flower by different agencies water, wind and insects.

Thus these flowers may be Hydrophilous (water pollinated), Anemophilous (wind pollinated) and Entomophilous (insect pollinated).

Q 2. *Give a general account of the storage of reserve materials in annual, biennial and perennial plants ?*

Ans Reserve materials found in plants either in the root or shoot or seeds, may be classed as solid and liquid, and these may be of various types .—

Reserve materials

Solid	Liquid
Starch, proteid, salt crystals, resin, gum, cautchouc, etc.	oils, fats, acids in solution, *e g.*, oxalic, citric, malic, acetic, tannic and alkaloids in solution.

Starch .

This occurs in all classes of plants (except in fungi) in the roots, stems and leaves.

Proteid :

In the form of crystals proteid is found in aleurone grains, as in castor seeds or wheat or pulses. In castor seeds, proteids are found in the forms of crystalloids and globoids. In wheat or pulses however no such crystaloids or globoids are seen.

Salt crystals :

In many plant cells an abundance of salt crystals are found. Calcium oxalate crystals may be found both in needle-shaped forms, called raphides or in octahedral forms. The former type is abundant in *kachoo* and the latter in onion scales. Calcium carbonate in the form of cystolith occurs in the leaves of Bat, Aswatha and Fig.

Fats and Oils :

Fats and oils are found in many flowers, seeds, fruits, leaves, stems and roots.

Generally two kinds of oils are seen in plants—fixed and volatile Cocoanut, mustard, linseed, olive, etc contains fixed oils. The agreeable odour of flowers, aromatic odour of tulshi stems or leaves or roots, the odour of pudina leaves or of lemon leaves—are all due to volatile or ethereal oils.

Acids

Citric acid in lemon, Tannic and Gallic acids in Babla or Khadir respectively are found in solution.

Gum and resin :

Gum is found in Babla or Sajina ; Resin is found in Pines. Various alkaloids are also found in different plants. Cinchona plant contains quinine, coffee plant gives caffein, morphin is contained in poppy, nicotin in tobacco, etc.

Or, What is a vascular bundle? What are its functions? Describe with labelled sketches a typical vascular bundle in the stems of phanerogamic plants.

Ans. For Ans. see *Ans*. to Q. 2 of 1953, First Paper.

Functions :

Since a bundle contains three sets of tissues, namely, xylem, cambium and phloem, each part is to be considered for its specific functions. In closed bundles however, the presence of cambium is wanting and hence it is closed

Xylem ·

(*a*) Xylem Vessels—carry the functions of conduction of water and nutrient solution from the soil to the leaves.

(*b*) Xylem parenchyma gives mechanical strength and stores up starch.

Phloem :

(*a*) Sieve tubes advance mechanical strength the part.

(*b*) Conduct proteids from the parts where these are formed or stored.

(*c*) Companion cells secrete ferments.

(*d*) Phloem parenchyma conveys nitrogenous foods from leaves to the parts where these are needed and also develops proteid-substances. The companion cells also carry on such functions.

Q. 3. *Explain briefly transpiration in a flowering plant*

Ans For Ans. see *Ans* to Q. 7 (*d*) of 1944, First Paper and of Q. 6 of 1949, First Paper.

Or, What is photosynthesis? How would you prove that a green plant manufactures food when exposed to light?

Ans. For Ans. see *Ans.* to Q. 3 of 1943, First Paper.

Q. 4. *Indicate with suitable sketches the more important differences in the external morphology of the vegetative organs of pea and maize plants.* Page 150

Ans. For Ans. see *Ans* to Q 5 of 1950, First Paper and Q. 8 of 1951, First Paper.

Or, Describe and compare with sketches the vegetative and reproductive structures of **spirogyra, yeast** *and* **mucor.**

Ans. *Spirogyra* For Ans. see *Ans* to Q 4. of 1951, First Paper

Yeast For Ans. see *Ans* to Q 6 of 1942, First Paper.

Mucor For Ans. see *Ans* to Q 5 of 1943, First Paper

Q 5 *Write notes on* **any three** *of the following* :—

(*a*) *Sporogonium*, (*b*) *Alcoholic fermentation*, (*c*) *Protoplasm*, (*d*) *Periderm*, (*e*) *Stoma*, (*f*) *Capitulum.*

Ans (*b*) **Sporogonium**

The sporophytic stage or fruit of moss is called the sporogonium It is produced after the process of fertilization and production of the oospore. The oospore develops into the sporogonium.

The sporophyte is attached to the gametophyte, *i e* , to the parent plant by means of a stalk called **Seta** with its **foot.** At the top of the seta develops the **Capsule** which has a cap called **operculum** The inner and central part of the fruit is occupied by a structure called **Collumela** round which and within the wall of the fruit are developed the spores The margin of the top of the capsule is fringed or toothed and is called the **peristome**. The capsule is covered by a structure called **calyptra.**

(*b*) **Fermentation**

Fermentation is a process of hydrolytic decomposition of a substance, such as sugar, by some enzyme, *e g* , zymase, as secreted by yeast plants in absence of air.

When yeast cells are thrown into a sugary solution, they decompose the sugar by the enzyme, zymase, secreted by

them and produce alcohol, carbon dioxide and some amount
energy :

$$C_6H_{12}O_6 = 2\,C_2H_5OH + 2\,CO_2 + \text{Energy}.$$

Here the carbon dioxide comes out in bubbles at the top the solution which appear as if boiling without appreciable ris of temperature and hence the name fermentation Since alcoh is produced in this sort of fermentation it is called alcoholi fermentation.

(c) ***Protoplasm*** *For Ans. see Ans. to Q. 1 of 195 First Paper.*

(d) ***Periderm :*** *For* Ans. see *Ans. to* Q. 7*(e)* of 1943, First Paper.

(*e*) **Stoma .** For Ans. see *Ans.* to Q. 7(*d*) of 1942 First Paper.

(*f*) **Capitulum** For Ans. see *Ans.* to Q. 7(c) of 1950 First Paper.

SECOND PAPER

Q. 1. *What is parthenogenesis ? How does it differ from asexual reproduction ?*

Ans **Parthenogenesis :** It is a degenerate form of sexual reproduction Here the female elements, *i e.*, the ova develop into adult organisms without being fertilised by male elements. In beehives, drones are produced from the eggs not being fertilised by males. Drones have their mothers but no fathers. Here the question of fertilisation does not appear. Thus when an oosphere or egg cell (ovum) develops into a normal product of fertilisation (oospore) without a preceeding sexual act, the phenomenon is known as parthenogenesis. Therefore it originates from a sexual stage which is unilateral and form a female unit.

In **asexual** reproduction, a biological unit multiply by producing spores or buds or overgrowth from its own body. Thus in Hydra a separable bud is formed which after attaining its maturity detaches itself from the mother and develops into a new adult. In mucor, such reproduction is seen by minute unicellular bodies called *spores* or rather *gonidia*. In sponge a clump of body cells separates out from its body wall and develops into a new adult. Sometimes by fission or fragmentation new individuals appear But such multiplication occurs in lower animals or plants In asexual reproduction there is no development of any sexual unit but rather a vegetative part takes part in the development into an adult unit and this part may or may not be detached from the parent unit for a time

Or, *Describe the life history of Monocystis.*

Ans. For Ans see *Ans.* to Q. 2 of 1942, Second Paper.

Q 2 *What are the types of cells found in the ectoderms of Hydra? Describe their structure and function.*

Ans For Ans see *Ans* to Q. 3 of 1941, Second Paper or to Q 4 of 1943, Second Paper.

Or, *Give an account of the digestive system of the prawn.*

Ans The digestive system of the prawn comprises the following parts —

(*a*) Mouth, (*b*) Oesophagus, (*c*) Stomach, (*d*) Digestive glands and (*e*) Intestine.

(*a*) **Mouth** .

It lies on the ventral surface of the cephalothorax and forms a large aperture In front it is bounded by a quadrangular plate, called **labrum** Laterally are the **mandibles** with their incissor processes placed inside the mouth. On the surface of these processes are two fleshy processes called labia On the sides of the mouth are seen the maxillae—one below the other.

(*b*) **Oesophagus** ·

It is a short vertical tube connecting the mouth anteriorly and the stomach posteriorly The grinding apparatus of the prawn, formed by the molar processes of the mandibles, are situated within the oesophagus.

(c) **Stomach**

A large space within the cephalothorax is occupied by a thin walled sac. This sac is the stomach. It has two parts—

cardiac and **pyloric.** The cardiac end is connected with the oesophagus. This cardiac end extends both in front and behind in the form of blind pouches Some chitinous plates are embeded in the wall of the cardiac end. These plates are of three kinds

(*a*) An oval plate in front of the opening of the oesophagus.

(*b*) A spear-shaped chitinons plate, on the floor of the oesophagus. This is known as **hastate plate.**

(*c*) On either side of the hastate plate there is a delicate rod with a row of fine hairs which project inward and overlap the margin of the hastate plate. The hastate plate and the two rods are enclosed between two elevated fleshy ridges called **guiding ridges** These help in sending the food into the pyloric portion from the cardiac end

(*d*) **Digestive glands**

In prawn the two digestive glands—namely, the pancreas and the liver are more or less fused with each other and hence the fused glands are together called Hepatopancreas The intestine passes through them The cardiac portion of the stomach is embedded in the glands. Two ducts open into the pylorus and the digestive fluid passes through these ducts into the pylorus.

(*e*) **Intestine**

It is a narrow tube coming from the upper cavity of the pyloric chamber, and passes through the digestive glands to the abdomen This intestine ends in the telson into a bulb-like swelling called intestinal bulb which in turn ends in the anal opening situated on the ventral aspect of the telson.

Q. 3 *Compare the structure of the skin of the leech and the fish.*

Ans **Skin of Leech** ·

It is formed of three layers, (*a*) the cuticle, (*b*) the epidermis and (*c*) the dermis.

(*a*) *Cuticle :*

It is the most external layer, non-cellular, transparent and very delicate covering of the whole body. It is the product of the epidermis which lies below this layer. This cuticle is periodically shed off along which some true epidermal cells are also shed off.

(*b*) It forms the inner layer and is formed of a single columnar layer of cells Each cell is a hammer-like unit having the head of each turned outward and the handles inwards Within the spaces produced by the handles are contained pigment cells and fine blood vessels together with some connective tissues The fine blood vessel being so superficial, a respiratory absorption of oxygen from air or water and outward passage of carbon dioxide readily go on There are some flask-shaped glands embedded into the epidermis, some of which secrete mucus to keep the surface slippery and others act as sense organs. Just below the epidermis there is much connective tissues and some pigments—yellow and green, brown and black.

(*c*) The next underlying layer is called the dermis It consists of fibrous tissue.

Skin of Fish ·

In fish the skin is a compact structure covering the body of the animal It is divisible into *Epidermis* and *Dermis* The epidermis produces mucus. Beneath this epidermis lies the dermis which produces *Scales* These scales may be of various types. In some they are ctenoid (Bhekti) and in others cycloid (Rohu) The scales protect the animals from external injury The skin also bears some glandular cells and sensory structures arranged in one or more sensory lines called "lateral lines" along the whole length of the body wall on either side of the trunk of the animal The dermis never contains any muscular element No pigment cells are there in the skin of the fish as in leech.

Ir, *Compare the respiratory organs of the prawn and the fish.*

Ans.

Prawn ·

1. There are *eight* gills on either side—the anteriormost is smaller and gradually each is bigger than that in front and the posterior one is the biggest. This whole thing is kept covered by the branchiostigite.

2 The gills are attached to (*a*) epimera, (*b*) arthrodial membrane and (*c*) the bases of the thoracic appendages.

3. The gills have no gill clefts.

4. The gill chamber is covered by the branchiostigite portions of the carapace.

5. Each gill consists of two rows of numerous quadrangular delicate plates.

6. These plates are supported by stout axis Each axis contains two blood vessels—one branchial vessel carrying impure blood from the sternal sinus to the gills and the other vessel carrying pure blood from the gills to the pericardial sinus. The gill plates contain net works of capillaries connected with the vessels of the gill axis Water enters the gill chamber from below and behind and passes out of it through the anterior openings The current is kept up by the flapping movement of the scaphognathite attached to the second maxilla as also by the backward movement of the animal in the water This scaphognathite bales out water in front while fresh water enters from behind There is no pharyngeal connection of the gills as in fish.

Fish .

There are *four* gills on either side These are attached to the *gill arches* There are five gill clefts reaching to the pharynx from each side *This is wanting in prawn* Each gill chamber is kept covered by an operculum This operculum is helped by three other bones - pre-, sub-, and inter-opercular bones Such is not the case in prawn. This operculum has on its posterior border a fleshy structure known as branchiostegal membrane *Each* gill arch has gill rakers and not scaphognathite as in prawn Each gill is composed of two filaments in Bhekti. There are two blood vessels behind each gill axis—one afferent and the other efferent vessels and both of them are connected with each other by capillaries.

Q 4. *Describe the structure of heart in toad or frog.*

Ans. For Ans. see Ans. to Q. 4 of 1947, Second Paper.

Or, Give an account of the structure of eye of any vertebrate, you have studied.

Ans. A vertebrate eye is globular in shape and is placed in a special cavity of the cranial bones called orbital cavity. The wall of the eye is composed of several distinct layers

1. Most anteriorly the eye-ball has a thin membraneous covering called *conjunctiva* This layer covers the inner aspect of the upper eyelid, then whole of the eye in front, and lastly it reflects on the inner aspect of the lower eyelid.

2 The next inner layer is the *Sclera.* It is formed of fibrous tissues and is a protective layer of the eye-ball

3 The outer part of the sclera is called the cornea and this cornea is the visible white part of the eye

Internal to the sclera is the black pigmented layer, called *choroid.* This acts as a black screen as in photography, to avoid light to the inner part of the eye. Just posterior to the cornea the choroid forms a muscular diaphragm-like structure called *Iris* In the centre of the iris is an opening, called *pupil* Irish is very sensitive to light. By intense light the pupil becomes smaller and by small or diffused light the pupil becomes bigger.

Just behind this iris is the crystalline double convex lens This lens is kept in position by suspensory ligaments. Some ciliary muscles are attached to the lens which help in accomodation of the lens for objects of various distances The next structure is the bag of *vitreous humor* which is transparent jelly-like fluid Behind this is the *retina*—a nervous structure produced by the optic nerve. Just at the junction of the two there is a spot called *blind-spot*

Just in front and behind the crystalline lens there are two spaces called *anterior chamber* and *posterior chamber* Each chamber is filled up with a clear transparent liquid

This retina receives the image formed by the system of lenses of the eye and acts as a screen as in photography.

Q. 5. *Explain the distinction between the following*

(*a*) *Notochord and Spinal chord,* (*b*) *Zygapophysis and Transverse process of a vertebra,* (*c*) *Artery and Vein.*

Ans. (*a*) **Notochord and Spinal chord** · For Ans. see *Ans* to Q. 7(*e*) of 1940, Second Paper, and Q. 7(*a*) of 1942, Second Paper.

(*b*) **Zygapophysis and transverse process of a vertebra.**

In a vertebral column each vertebra articulates with two other vertebræ excepting the first and the last. Thus if an intermediate vertebra is seen or examined it will be found that there are two articular surfaces at which each articulates with the other two. Each such articular surface is known as zygapophysis as in toad or guinea-pig In these animals each vertebra has a zygapophysis anteriorly to articulate with the anterior fellow and a posterior one to articulate with the posterior fellow.

Transverse process, as observed in a typical vertebra of toad or guinea-pig are two lateral bony processes arising from the junction of the centrum with the neural arch—one on each side. Each is directed (laterally) outwards and slightly downwards.

(c) Artery and Vein .

They differ both functionally an structurally ·

Artery	*Vein*
1 Artery carries *pure blood* except pulmonary artery	1. Vein carries *impure* blood except the pulmonary vein which carries pure blood.
2 Carries blood away from heart	2 Carries blood towards heart.
3. A big artery branches into different directions, forward	3 A big vein *receives* other veins as tributaries, inwards
4. An artery is formed of *three* layers (*a*) Tunica adventitia—the outermost layer formed of fibrous tissue. (*b*) Tunica media—the middle layer—formed of muscular tissues (*c*) Tunica interna—the innermost layer formed of elastic endothelial tissues.	4. A vein is also formed of three layers as an artery.
5. Its wall is tough and elastic.	5. Its wall is soft and nonelastic
N B. Tunica media is many-layered.	*N.B.* Tunica media is a few layered.

1955

FIRST PAPER

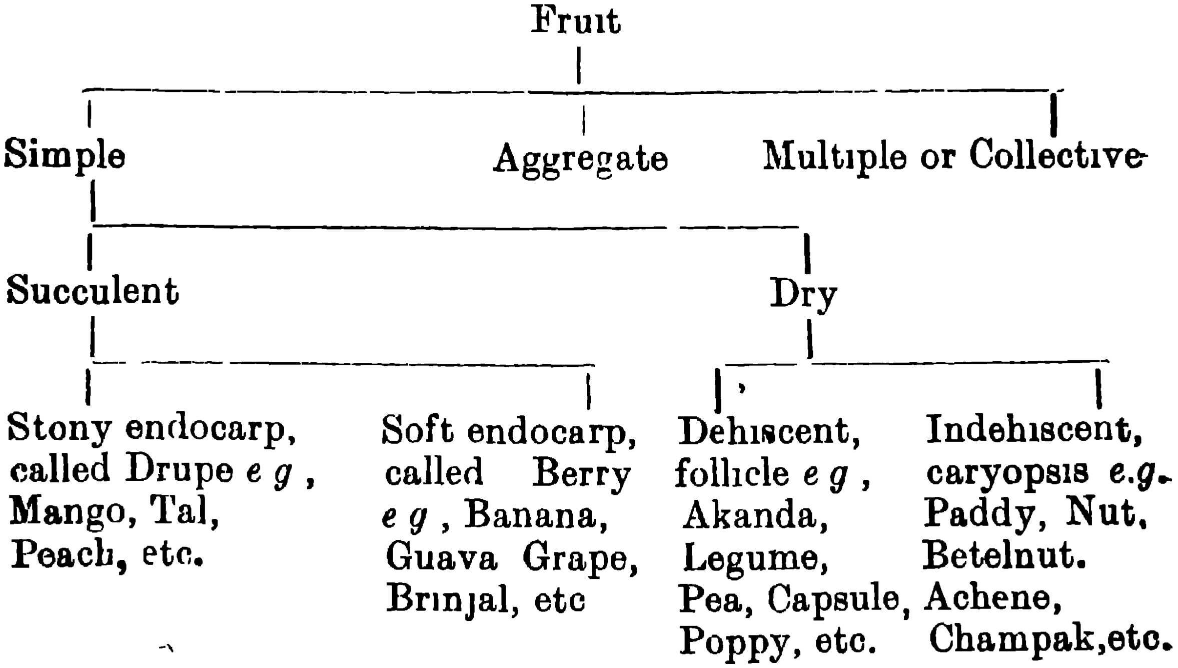
Q. 1. *Point out the main differences between the 'living' and the 'non-living',*

Ans. See Ans to Q. 1, of 1940 First Paper.

Q. 2. *What is a fruit ? Give a short account of the classification of fruits with examples.*

Ans. After fertilization is complete, the ovary matures into a fruit, *i e* , a ripened ovary after fertilization is called a fruit.

The following table gives the classification of fruits :



- Fruit
  - Simple
    - Succulent
      - Stony endocarp, called Drupe *e g* , Mango, Tal, Peach, etc.
      - Soft endocarp, called Berry *e g* , Banana, Guava Grape, Brinjal, etc
    - Dry
      - Dehiscent, follicle *e g* , Akanda, Legume, Pea, Capsule, Poppy, etc.
      - Indehiscent, caryopsis *e.g.* Paddy, Nut, Betelnut. Achene, Champak,etc.
  - Aggregate
  - Multiple or Collective

Or, Mention the important primary internal and external structural differences between roots and stems.

Ans. See Ans. to Q. 3 of 1940, First Paper.

Q. 3. *Describe various types of vascular bundles in plants with examples. Give sketches.*

Ans. Just the inner ring next to the pericycle layer of the stem or root of a plant shows the layers of the vascular bundles in a ring. Each of the bundles consists of :

(*a*) Phloem, (*b*) Cambium and (*c*) Xylem. Of these, the phloem is situated towards the pericycle *i.e*, towards the circumference and the Xylem occupies the inner part *i.e.*, directed towards the centre or pith. The Cambium occupies the middle part *i e.*, lies in between the phloem and the xylem.

The xylem consists of vessels with thick and lignified walls but the phloem vessels have their cellulose walls. The protoxylem is situated towards the pith and consists of spiral and annular vessels. The newly formed vessels constitute the metaxylem and have pitted or reticulate walls The protophloem lies towards the pericycle and consists of sieve-tubes and companion cells. The cambium cells remain meristematic They constantly add new cells to xylem on one side and to phloem on the other. The vascular bundles are separated by some parenchymatous cells. These form the medullary rays.

N B. The above descriptions apply to dicot plants only.

Or, Describe the structures of a dorsiventral leaf Illustrate.

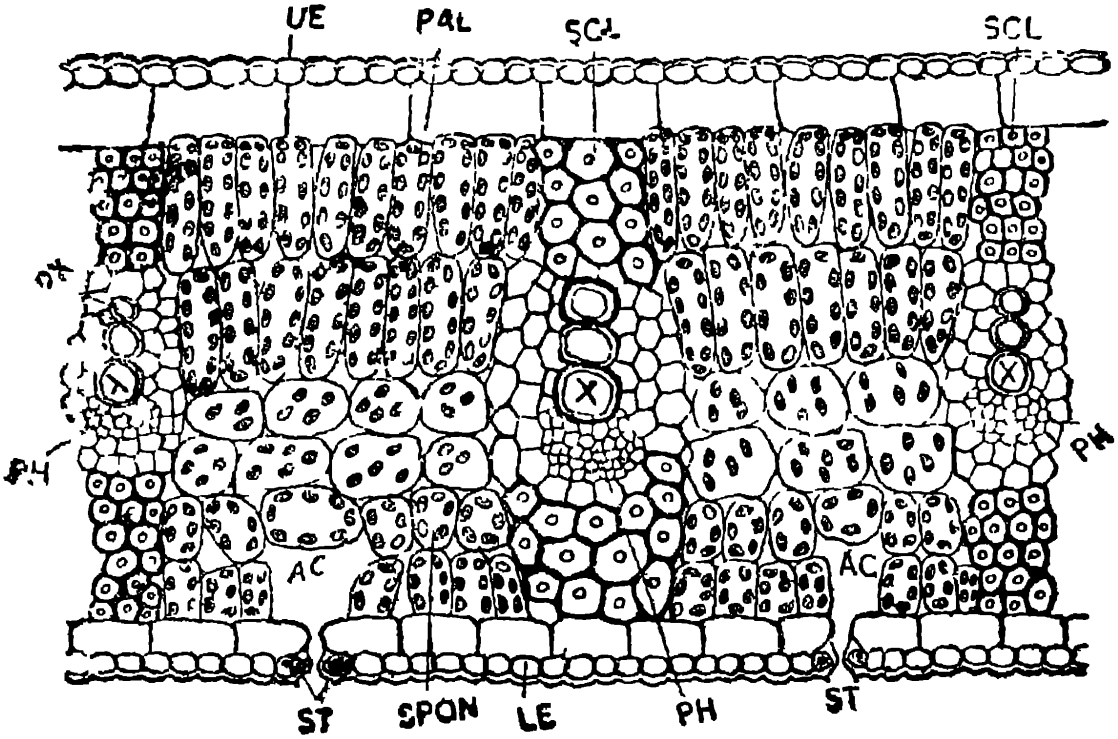
Ans. On examining a transverse section of a dorsiventral leaf we get the following —

There are two epidermal layers, one on the ventral surface or the upper surface and the other on the dorsal surface *i e.* the undersurface of the leaf Within these two epidermal layers lie the messophyll tissue and the vascular bundles. The upper part is made up of closely packed parenchymatous cells and these are elongated cells. These cells contain a large number of chloroplasts. This tissue is called pallisade parenchyma. The next layer of cells consists of loosely packed round cells with large intercellular spaces for air in between them These contain a small number of chlorophylls and are called spongy parenchyma. Next are seen the bundles of vessels. The xylems are placed towards the upper surface and phloem towards the lower surface. The bundles are closed since there is no cambium.

The upper epidermis is a continuous one. The lower epidermis, however, is interrupted by minute openings called stomata bounded by two kidney-shaped guard cells. Just behind each of these stomata there is a large air space which forms a communicating passage between the chamber inside and the air outside. In many cases hairs are seen from the epidermal tissues on both sides. The hairs on the lowers surface are generally numerous.

Thus we get in a leaf section the following :—

1. Upper epidermis in one layer.
2. Pallisade parenchyma.
3. Spongy parenchyma with air spaces.
4 Vascular bundles.
5 Lower epidermis in one layer with stomata.
6 Hairs or trichomes from both the epidermal layer, but this is not always seen.



Transver. section of a dorsiventral leaf
UE—Upper Epidermis
SCL—Sclerenchyma
PAL - Palisade tissue
PX—Protoxylem
PH—Phloem
AC—Air cavity
SPON—Spongy parenchyma
LE—Lower epidermis
ST—Stomata

Q. 4. *Name and illustrate with reference to particular types the various methods of reproduction found in plants.*

Ans. Reproduction is the process of producing new individuals from the parents.

Plant reproduction may be of the following types :—

1. A-sexual.
2. Vegetative.
3. Sexual.

Illustrations :—

1. A-sexual reproduction is found in cryptogamia. Here the reproduction is carried on by spores which may either be motile or non-motile The motile spore moves in water with the help of its cilia and is called Zoospore. The spores of mucor are called gonidia.

2. Vegetative reproduction consists in the detachment of a more or less specialised part of the parent plant This being detached produces a new plant *e g*, Patharkuchi. In spirogyra a simple splitting of the mother cell produces new spirogyra plants In moss a special kind of bud called gemmœ produces new moss plants Bulbils in angiosperms, as also grafting propagate the race

3. Sexual reproduction either by fertilisation or by conjugation is carried on in plants. In spirogyra or Mucor, congujation is seen

In all phanerogams fertilization is the main process of reproduction. Here gametes of two strains i e. male and female unite together to give rise to a new plant Zygote or oospore is the term applied to the product of sexual reproduction.

Q. 5 *Compare the life-history of a fern with that of a pea plant.*

Ans. The whole life-history of a fern consists of two phases or stages , viz : (*a*) Sporophyte and (*b*) Gametophyte. Each stage is independent in itself.

Sporophyte :

The plant itself represents sporophytic stage. The foliage leaves during spore formation become sporophylls The spores are grown on the margin of the leaves in spore boxes or sporangia. When matured, the spores are scattered on the ground and thus become detatched from the mother plant to lead an independent life of gametophytic stage.

Gametophyte :

After falling to the ground each spore produces a prothallus which is independent in itself with respect to all sorts of functions On the prothallus gametes are grown Gametes are of two strains Two different units e g , male and female combine together to give rise to an oospore and this is the product of fertilization Another name for an oospore is a zygote. From this oospore a new fern plant develops to start the next sporophytic generation Similarly, the whole life-history of a pea plant also consists of two stages viz Sporophytic and gametophytic.

The seed of a pea plant contains the embryo. This embryo represents the first stage of sporophytic generation. The pea seed after germination develops into an adult pea plant. On the adult pea plant flowers grow A flower is nothing but a place for the growth of the gametophytic generation In the flower grow the androeciun and gynoecium These two distinctly different units unite to form an oospore from which the new embryo of the next generation grows Thus the flower may be compared with the prothallus stage of the fern

Here we see that the gametophytic stage of the plant is fully dependent on the mother plant whereas in fern this stage is quite independent of the parent plant.

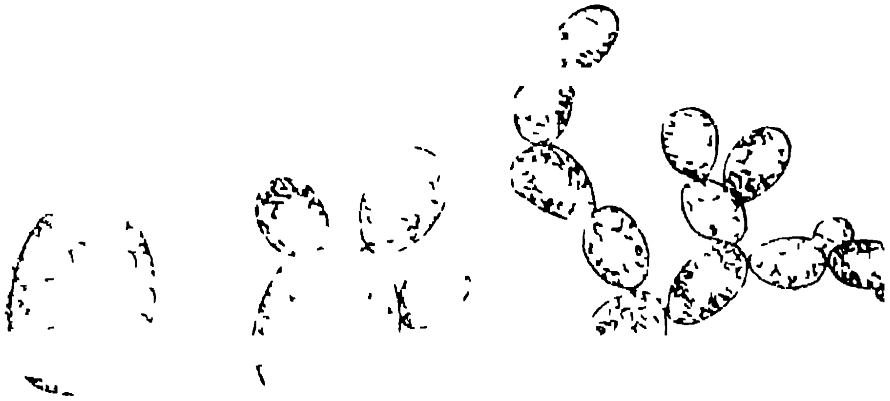
Hence the pea plant as a whole represents the sporophytic generation and the gametophytic generation as also a part of the sporophytic stage of the next generation.

Or, *Describe the structure and life-history of the yeast plant and compare with that of the mucor.*

Ans.

Yeast :

It is unicellular. Cells are oval or spherical occurring singly or in groups No chloroplast is seen in it. Each cell has a distinct cell wall Vacuole and cytoplasm both are present. Ordinarily nucleus is not seen but it may be seen after proper staining. Some cells give out one or more outgrowths of similar structures. Sometimes they form a chain of gradually smaller cells.



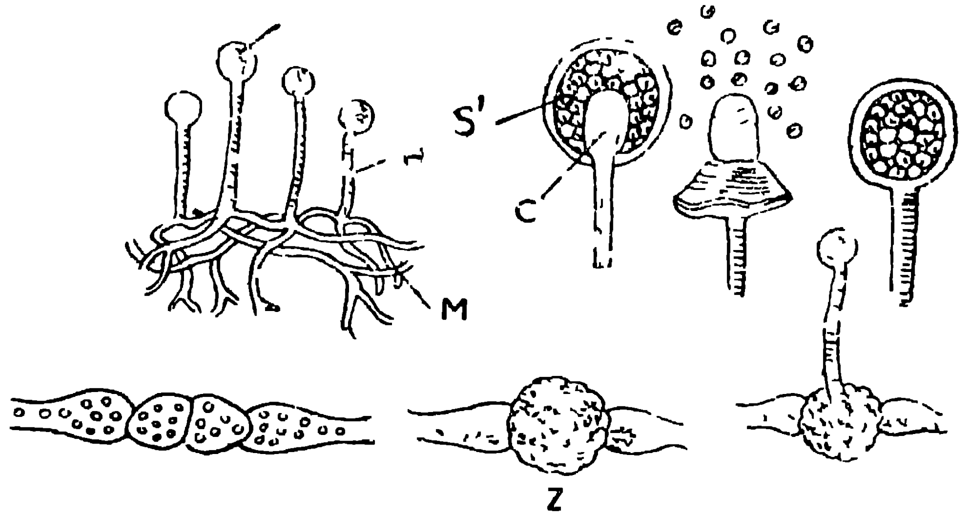
Yeast plant.

Thus the yeast reproduces by budding when in sufficient sugar solution Yeast also reproduces by sexual method by forming an oospore. Conjugation is not unknown.

Mucor

When mucor is seen under microscope the following structures are revealed.

A zone of net work of white slender thread-like structure. This is mycelium. Each thread is a hypha. No chloroplast is seen It is unicellular but contains many nuclei and not one uncleus as in yeast. Hence it is called a *cœnocyte.* Some hyphæ are erect and aerial. They bear spherical bodies at their ends. These are called sporangia. Each sporangium contains spores Each spore can produce a new mucor plant asexually. Within each sporangium is seen a



M - Mycelium.
H—Hypha.
S—Sporangium
C—Columella
S'—Spores
Z—Zygospore

columella Mucor also reproduces sexually by conjugation producing zygospore.

SECOND PAPER

Q 1. *Explain the evidences of Organic Evolution*

Ans. See Ans to Q 1, second paper, 1943.

Or, *Describe the circulation of blood through the heart of a guinea pig.*

Ans The impure blood from all the parts of the body is carried away to the right auricle by means of the two superior venæ cavæ and by the inferior vena cava. From the right auricle the blood passes into the right ventricle by the auriculo-ventricular opening which is guarded by the tricuspid valve. This valve is worked by Chordae Tendineæ attached to the papillary muscle.

Now the right ventricle contracts and the blood is driven into the pulmonary area by means of the pulmonary arteries.

This opening is guarded by three semilunar valves which prevent the backflow of the blood

The two pulmonary arteries branch into capillaries on the wall of the lungs. Here the blood is oxygenated and also becomes devoid mostly of the carbon dioxide. This purified blood again returns to the left auricle by means of the two pulmonary veins which however unite to form one trunk before it reaches the left auricle Now this pure blood passes from the left auricle to the left ventricle, the opening being guarded by the mitral valve This mitral valve is worked and supported by Chordæ Tendineæ as also by the papillary muscles

Finally, the left ventricle drives the purified blood to the body. During this time the mitral valve is closed. Hence no regurgitation takes place into the left auricle The blood is gradually pumped into the aorta This opening is being guarded by three semi-lunar valves The coronary arteries arise just above the trunk of the aorta and supply the heart. Next, the blood runs into the systemic parts of the body

Q. 2 *Give an account of reproduction in hydra.*

Ans See Ans to Q 2, second paper 1916

Or, *Compare the pelvic girdles of toad and guinea pig.*

Ans See Ans to Q 5, second paper, 1943 and Q 6, second paper, 1944

Q 3. *Describe the different modes of respiration in a frog.*

Ans See Ans to Q 6, second paper, 1950

Or, *Describe the circulatory system of a prawn.*

Ans See Ans. to Q 3, second paper, 1948.

Q 4 *Describe the reproductive system of a leech.*

Ans See Ans. to Q 3, second paper, 1951.

Or, *Describe the structures in a typical transverse section taken through the body of a leech.*

Ans See Ans. to Q. 2, second paper, 1947.

Q 5. *Write notes on :—*

Retina , statocyst , metamorphosis.

Ans *Retina* . See Ans to Q. 7, (*f*), second paper, 1940.

" *Statocyst* See Ans. to Q 7, (*d*) second paper, 1940.

" *Metamorphosis* See Ans. to Q. 7, (*d*) second paper, 1943.

1956

FIRST PAPER

1. *Describe the structure of an albuminous dicotyledonous seed and its mode of germination Give necessary sketches.*

Ans. To describe an albuminous dicotyledonous seed let us take the type of a castor seed which satisfies all the conditions.

It has the following parts —

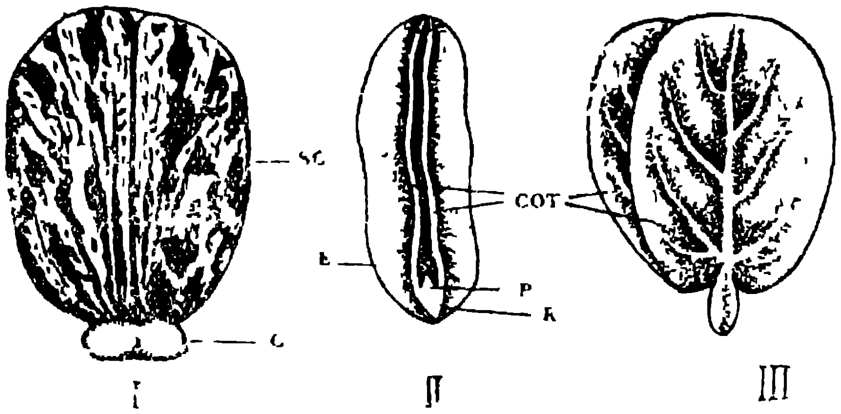
1. Seed coat,
2. Endosperm,
3. Embryo.

The seed coat is dry and hard It has some marking on its surface It is oval in shape A swelling is seen at one pole of the seed and is called the *caruncle* Just underneath the caruncle is the micropyler opening through which water passes into the seed substance If the caruncle is carefully removed the micropyler opening is seen clearly Just near the caruncle is seen the hilum The seed coat when carefully removed, a thin membranous layer covering the endosperm is seen. This may be called the tegmen Some Botanists do not hold it In their opinion the testa and the tegmen are adherent together. The endosperm is a thick fleshy substance and is called albumen. This contains the food of the embryo and oil

In between the two fleshy endospermic bodies lies the embryo The embryo consists of two cotyledons one plumule and a radicle Both the cotyledons have leaf-like structures with prominent veins over its surface At the junction of the two cotyledons is seen the plumule. The radicle is seen at the opposite end of the axis

During the germination under suitable conditions, in castor seed as also in other albuminous seeds, the leafy cotyledons lie within the two cotyledons and takes its nourishment from the endosperm and supply the same to the embryo. The cotyledons become nurished and thereby the endosperms gradually become thin and thin. Next the green cotyledons come out

At the first stage the hypocotyle is seen curved, next it becomes straight. The cotyledons remain attached to the hypocotyle and thus the germination is called *Epigeal.*

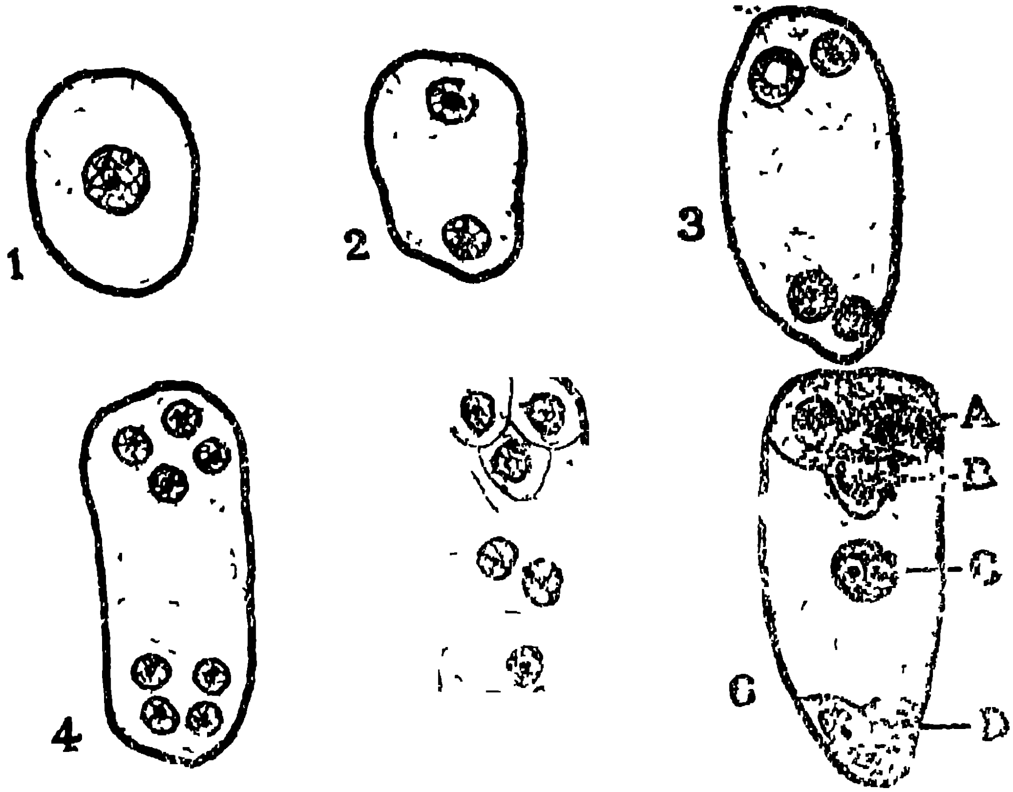


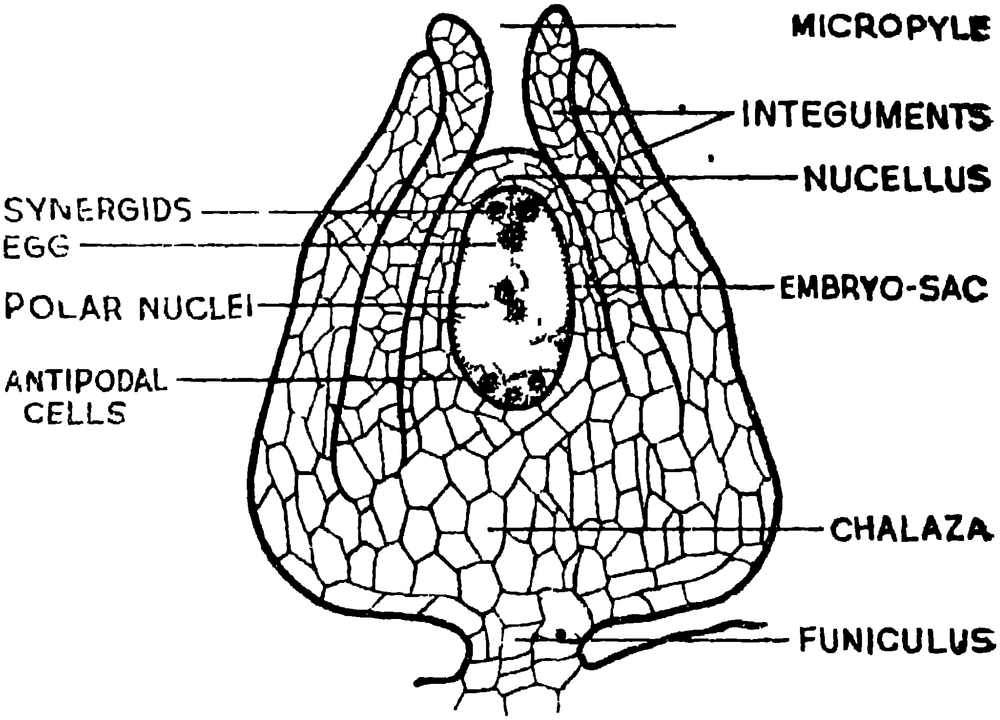
Structure of Castor Seed : I—Seed with testa , II—Seed after removing the testa. III—Cotyledons
Sc —Seed coat or testa , C —Caruncle ,
E.—Endosperm , Cot.—Cotyledons ,
P —Plumule , R -Radicle.

Or, *Give with drawing a description of the structure of an ovule at the time of Fertilisation.*

Ans The embryo sac within the mucellus grows in size and the nucleus divides into two daughter nuclei, one of these reaches the top of the ovule and the other reaches the bottom of the embryo sac Next each of these two nuclei divides into four daughter nuclei Thus eight new nuclei are formed. One from each set travels and reaches the central part of the ovule. They two fuse together and form what is called **secondary nucleus** or **Polar nucleus.** Each of these divided nuclei surround themselves with protoplasm and cell-wall.

Thus three sets are formed, one set consisting of three nuclei at the top, of which the two side nuclei are called **synergidæ** and the middle one is called the **egg.** All these three together are called **egg apparatus.** The other three lying at the base of the ovule are called **antipodal cells.** At this stage the ovule is ready for fertilisation. Just before fertilisation, however, the antipodal cells disappear.





Full view of the ovary just before fertillisation.

Q 2. *What are mechanical tissues? Give an account of the nature and distribution of mechanical tissues in a transverse section of any dicotyledonous stem Illustrate your answer with sketches*

Ans The mechanical tissues in a dicot stem as seen in a transverse section are given below —

1 Collenchymatous tissues ;
2 Sclerenchymatous tissues ;
3 The tracheal tissues of the vascular bundles.

Distribution of the mechanical tissues in a dicot stem is seen mostly where they are needed. Since the plants have to resist the strain of the wind and weight or load of its body, the mechanical tissues are mostly distributed towards its periphery and also in the vascular bundles.

Collenchymatous tissue

It lies just inside the epidermis Here the parenchymatous cells become thickened by the deposition of cellulose and get thickened generally at the corners of the cells. Collenchymatous cells *contain* protoplasm and are capable of carrying *on nutritive functions*

Prosenchymatous tissue

Prosenchymatous tissues *are present in woody parts of plants*. These are the fibrous tissues These are elongated and thick-walled cells with pointed ends dovetailing each other

Sclerenchymatous tissue

This type of tissues is the main type of mechanical tissue in plants The cells forming the sclerenchymatous tissue do not contain any protoplasm The cell-walls are highly thickened and well-lignified Really these cells are *prosenchymatous* in nature and generally occur in bands or bundles.

Such cells in different forms are found in stony parts of some fruits Here the cells are round in shape and are called sclerotic cells.

Or, *Give a general account of the structure, occurrence and functions of plastids*

Ans. For *Ans*. See Ans. to Q 2, first paper, 1945.

Q 3. *Describe the process of absorption by roots. Describe a simple experiment in support of your answer.*

Ans Plants absorb their foods in solution by means of their roots from the soil They cannot take solid food. The process of absorption is carried on by the root hairs The cellular plants absorb liquids through all the cells by Osmosis.

The epiphytic plants get water from the atmosphere in shape of moisture and this they do by their hanging aerial roots through special cells called velamen which lie just below the epidermis.

In case of higher plants root-hairs and piliferous layers are the chief organs for absorbing water or food solution from the soil. The root-hairs by their *endosmotic* action draw in the food solution from the soil and get turgid. This turgidity sends the solution to the next inner cortical cells and which in turn send the same into the vessels These vessels ultimately carry the watery solution into the leaves The cellulose wall of the root hairs serve as permeable membrane The cell sap is denser and the solution from the soil is dilute. Thus the process of endosmosis goes on Sometimes however it so happens that some food elements in the soil do not dissolve in the hygroscopic water In such cases the root hairs excrete out some acids which get these insoluble salts dissolved and the solution is next drawn in by hairs

Thus the absorption of water is due to the action of living cells of the roots The living cells carry on some chemical action This chemical action again demands the supply of water In this way water is taken in by the root-hairs from the soil and is sent to the cortical tissues

Experiment :

During spring time if the stem of a herbaceous plant is cut, some water is seen oozing out of the cut surface. This is called "*Bleeding*" or "*Weeping*" of plants Thus it is shown that water rises in the stem of the plant due to what is called the 'Root pressure'.

Or, Describe simple experiments to demonstrate geotropism, transpiration and anœrobic respiration.

Geotropism :

Ans. Geotropic movement may be of two types —

(*a*) Positive and (*b*) Negative.

When a seedling is placed on a horizontal plane and is protected from the action of light, it is found that the stem gradually curves until it is erect and the young root turns to the opposite direction till it points vertically downwards. Thus the roots are positively geotropic and the shoot is negatively geotropic.

Transpiration :

Two pieces of filter paper are soaked in cobalt nitrate solution and perfectly dried The two pieces of filter paper appear faintly blue in colour Now choose a growing pot plant Place a leaf of this plant between these two pieces of filter paper and fix them by clips. After a short time however the blue colour of the filter paper on the under surface of the leaf will turn pink This proves that water vapour is coming out of the under surface of the leaf **(N B** It is water that turns dry blue cobalt paper pink).

Anærobic respiration :

Fill up a jar with N_2. Put some growing seedling into it. Cork the mouth of the flask tightly so that no air or oxygen is allowed to enter the flask Keep this arrangement for a few hours Next open the cork and examine the gases of the flask This inside gas of the flask now turns clear lime water milky Thus the seedling have respired and have given out carbon dioxide but got no supply of oxygen Hence they have respired in absence of oxygen or air. Such respiration is called anærobic respiration.

Q 4. *What is a gametophyte ? Compare the structure of the gamtophyte in Moss and Fern. Give suitable sketches.*

Ans For Ans. See Ans. to Q. 7, first Paper, 1952.

Or, *Give an illustrative account of the external morphology of the sporophyte of the Maize plant.*

Ans. For Ans See Ans. to Q 5, First paper, 1940.

Q. 5. *Write notes on any* **five** *of the following :—*

(*i*) *Epiphyte*, (*ii*) *Symbiosis*, (*iii*) *Lenticel*, (*iv*) *Chromosome*, (*v*) *Fermentation*, (*vi*) *Sorus*, (*vii*) *Sporangium*.

Ans.

(*i*) *Epiphyte* : This type of plant grows on another plant and uses its host as support only. This plant sends down its roots into the air or along the surface of the branches of the host plant. This plant derives its nourishment from the air by means of hanging roots as in orchids.

(*ii*) *Symbiosis* For Ans See Ans. to Q 7(*a*) 1949, First Paper.

(*iii*) *Lenticel* This usually appears at places previously occupied by the stomata which are broken down during secondary growth in thickness Each of these openings consists of a few rows of corkcells loosely set with each other leaving distinct intercellular spaces, through which the gaseous interchange is again established.

(*iv*) *Chromosome* . For Ans. See Ans to Q. 7(*c*), First Paper 1947.

(*v*) *Fermentation* It is a process of decomposition of a complex substance into simpler ones and this is brought about by a substance called 'ferment' or 'enzyme' This acts like a catalytic agent A small quantity can bring about much amount of decomposition without itself being used up or taking any part in the decomposition In the process of fermentation the whole thing appears, like boiling without appreciable rise in temperature.

When a yeast is thrown into sugar solution, sugar is decomposed into alcohol and carbon dioxide This latter forms froth over the surface of the solution and appears like boiling but with a little rise of temperature.

(*vi*) *Sorus* In fern plant spores are produced in a sporebox called sporangium Several such sporangia are collectively arranged by means of a covering called inducium. Each of these sporangia are stalked having anulus over each. Such a collection of sporangial group is called a sorus

(*vii*) *Sporangium* . It is the spore-producing organ found in moss. It can be called a fruit It consists of a foot, a long seta and a capsule at the top of the seta. The capsule has an operculum When the fruit ripens, the operculum is thrown off and peristomes are seen along the circumference of the top of the fruit. There is the columela inside the fruit which helps in the dispersion of the spores from the fruit.

SECOND PAPER

Q. 1. *Describe the process of capture of food by* **Amoeba** *and its method of nutrition*

Ans. For the Ans. of the 1st part see Ans to Q 2. Second Paper, 1943.

The food of amoeba consists generally of minute vegetables. The food is surrounded by its pseudopodia and engulfed together with some water This forms the food vacuole in the body. Next some digestive ferment is produced in the vacuole which digests the food and the digested product is absorbed and assimilated at last The undigested part is thrown out from any part of its body during its gliding from one place to another This is the faeces of amoeba This digested and assimilated food serves for the nutrition of the animalcule providing growth and energy for movement and reproduction After complete digestion of the food the food vacuoles disappear.

Q 2 *Give an account of the cells found in the ectoderm of* **Hydra**

Ans The ectoderm forms the outer layer of Hydra It includes the following different kinds of cells :

(*a*) Musculo epithelial cells, (*b*) Interstitial cells, (*c*) Cnidoblastic cells, (*d* Sensory cells.

The musculo-epithelial cells are comparatively larger cells. These are conical in shape The broader ends are directed outward and the narrower ones directed inwards.

From the tips of these musculo-epithelial cells are seen some contractile processes which serve the purpose of muscular action for the animal Thus they may be called neuromuscular since they contract under certain stimuli.

(*b*) **The interstitial cells** are rounded in shape and smaller in size than the musculo-epithelial cells. These lie in between the spaces formed by the cone-shaped musculo-epithelial

cells From these interstitial cells grow the stinging, reproductive and other cells.

(*c*) Next the **Cnidoblast cells** or stinging cells as they are called, are seen embedded in the ectoderm They are more abundant on the upper part of the body of the animal and more so in the tentacles. They are absent in the basal disc

Each cnidoblast cell consists of a nematocyst. Each nematocyst consists of a sac which is a doubled layered pouch containing a long filamentous thread which remains coiled within the pouch Each filament may be prolonged into a long hollow thread like structure called **lasso** The sac is filled with, presumably, a poisonous fluid From the end of the cnidoblast cell projects a hair like structure called cnidocil. This acts as a trigger So sensitive it is that even a slight stimulus throws out the nematocyst from its pouch straight outside The nematocyst may be of three types

1 Penetrant, 2 Glutinant and 3 Volvent.

The penetrant types are longer and barbed The glutinant types are short-coiled threads The volvent types are just like penetrant but shorter and without barbs

(*d*) **Sensory cells**

These cells lie in the interspaces of the musculo-epithelial cells Some sensory hairs are present on the outer ends of the cells In the inner aspect of the musculo-epithelial cells there is a net work of ganglion cells and nerve processes. These cells are more numerous on tentacles and on the basal disc

(*e*) Another type of granular cells called glandular cells are seen on the basal part. These cells secrete some glutinous substance

Q 3. *Describe the heart of a toad and the circulation of blood through it.*

Ans. For Ans see Ans. to Q. 4, second paper, 1947.

Q. 4 *Describe and compare the respiratory organs of the prawn and the fish.*

Ans. For the respiratory organs in the fish see Ans. to Q 6, second paper, 1950.

In Prawn :

The respiratory organ of the prawn consists of the following parts :

1. The inner lining of the carapace on either side.
2. All the three pairs of epipodites.
3. Eight pairs of gills on the sides covered by the carapace and situated within the gill chambers.

Eight gills are present on either side. Seven of them are easily visible while one remains hidden under the second gill. Each gill is semilunar in shape and the anterior one is the smallest and each successively increases in size as we go to the posterior and thus the posteriormost gill is the largest.

There is no branchial arches as in a fish, neither any gill raker. The first gill i e, the anteriormost one is connected with the second maxilliped, the second and the third on its inner side are attached to the arthroidal membranes which in turn are connected with the third maxilliped The rest five are attached to the walking legs. The attachment of the gills gradually passes from ventral to the dorsal aspect as we see from before backwards

Each gill consists of two rows of numerous quadrangular plates arranged like the pages of a book These plates are supported by stout axis This axis again is attached to the side of the body by a short stalk The axis contains both the blood vessels, namely, one carrying impure blood from sternal sinus to the gills. This is called the branchial vessels The other vessels carry pure blood from the gills to the pericardial sinus and are called branchio-cardiac vessels.

Q. 5. *Give a description of the body wall of a leech*

Ans For Ans. see Ans to Q. 2, second paper, 1947.

Q. 6. *What is organic evolution and what morphological evidences are there in its support ?*

Ans. For Ans. see Ans to Q. 1, second paper, 1943.

Q. 7 *Write notes on ;—*

Corpora bigemina . odontoid process ; Area pellucida.

Corpora bigemina

Mid brain, in vertebrates, consists of two rounded bodies on the dorsal aspect This portion develops from the median embryonic or second primary vesicle of the brain. These two rounded bodies are called Optic Lobes The lateral walls and the floor of this region form what is called the Crura Cerebri The optic lobes or the corpora bigemina is formed from the roof and these two are hollow The crura cerebri connect the mid brain with the fore brain in front and the hind brain behind.

Odontoid process :

The second cervical vertebra or the axis can be differentiated from all other vertebræ by a process known as odontoid process at its anterior part The broad flat centrum is produced into this process which fuses with the atlas or the first vertebra at its centrum, though this centrum is unrepresented in the atlas, as in a guinea pig In other words the odontoid process is considered as the transformed centrum of the atlas.

Area pellucida :

In the development of chick, if we follow the egg after it has been laid and when the mother sits upon it, on surface view, a central ill-defined area is seen This is the area pellucida. The surrounding area of the pellucid area is called the area opaca. The area opaca is the white area. The chick begins to form and develop in the area pellucida and this is seen sometime after the mother sits on it.

Q. 8. *State the distinctive features of muscular and nervous tissues*

Ans. Muscular tissue .

This consists of muscle cells or muscle fibres. It may be smooth or striped transversely. The smooth cells are slightly elongated having a nucleus in each cell These cells are seen *striped longitudinally* It is formed in the intestinal gut of the vertebrates. In striped muscle cells the striations though faint, are seen *transverse.* Striped muscle cells also have a nucleus in each. It may be branched It is found in heart of the vertebrates This tissue may contract or relax according as the stimuli.

Nervous tissue :

This tissue consists of modified cells which give rise to one or more thread-like processes called nerve fibres These fibres collectively are known as nerves. Each nerve may be formed of long fibres known as **axons** and some of short fibres known as **dendrons** The axons and the dendrons are collectively known as *neurons.* The nerve fibres are covered with sheaths and they are called **medulated.** The sympathetic or para-sympathetic nerves are not covered by sheaths and hence they are **non-medulated.** The nerve cells are generally collected into small masses called **ganglia** Nerves are the organs to carry impulses to or from the peripheral body from or to the central system.

BIOLOGY

1957

First Paper

Q. 1. *What is endosperm ? Give an account of its origin and relation to embryo.*

A seed contains the embryo. This embryo is the sleeping baby plant. It consists of the axis. One part of the axis is the plumule and the other part is the radicle. At the junction of the plumule and radicle there is one or two structures, called cotyledons. Cotyledons are seed leaves and contain the food of the plant. Sometimes however the food remains in a separate structure from the cotyledons. This food is albumen and is called *Endosperm.* The seeds containing no albumen may be called non-endospermic.

Origin :

Just before fertilization the embryo sac contains two *definitive* nueclei in the centre. These two may remain side by side as discrete or they may fuse together. Next, when the pollen-tube enters the sac it contains two generative nuclei at its tip. Next the tip swells and bursts when one of the generative nuclei fuses with the female gamete to form the oospore. The second nucleus then "by double fertilization" fuses with the definitive nucleus to form the endosperm. This endosperm is thus formed of three nuclei and hence has "3n" chromosomes.

Relation to Embryo :

In exalbuminous seeds the endosperm is used up during the formation of embryo but in albuminous seeds it persists containing the food of the embryo during future germination.

Or,

Q. 1. *Describe briefly the functions of normal and modified leaves.*

Ans. For *Ans.* see *Ans.* to Q. 5. First Paper, 1941 or First Paper, 1942.

Q. 2. *What do you mean by meristematic tissues? Where do they occur in a stem and what tissues do they form?*

Meristematic tissue consists of cells which possesses the property of continuous growth. Thus cell division goes on continuously and repeatedly. These cells forming the meristem is generally polygonal or round or elongated having very thin cellwalls of cellulose material only. There is no inter-cellular spaces. Each cell has a mass of cytoplasm with a big nucleus but no vacuole is present.

They occur in the apex of stems and are called *apical* meristems. Intercalary meristems also arise from the primary meristems during the secondary growth in thickness of the stems. This occurs in cambium. From permanent tissues sometimes secondary meristems develop. This occurs in time of secondary growth in thickness in stems and also in roots. In such cases the medulary rays become meristematic and begins to produce interfascicular cambium which ultimately produce the cambium ring by joining with the primary cambium. Phellogen or the cork cambium also develops from the cortical cells during secondary growth.

All other tissues that are permanent develop from the meristematic tissues. Thus vascular, glandular, laticiferous and cellular tissues including parenchymatus, sclerenchymatus and prosenchymatus and all, develop from the meristematic tissues.

Or,

Q. 2. *What is meant by secondary growth? Describe with the help of a sketch the position of different tissues in a transverse section of the stem of a dicotyledonous plant in which secondary growth has just commenced.*

Secondary growth :

In annual or herbaceous plants, the stems and roots do not show much increase in thickness or girth. But in trees or shrubs the thickening of bulk takes place from year to year. This increment is due to the activity of the cambial layer of tissues either fascicular, interfascicular or cork cambium. These cambiums act as secondary meristems and the growth produced by the activity of these cambiums is known as **Secondary** growth.

For the rest of the *ans.* see *ans.* to Q. 2, First Paper, 1953.

Q. 3. *What gaseous exchanges take place between a green plant and the atmosphere? Refer to the physiological processes with which these gaseous exchanges are concerned.*

Ans. The gaseous exchanges that take place between a green plant and the atmosphere may be divided into two parts:

During Photosynthesis and during respiration.

For photosynthesis see ans. to Q 3, First Paper, 1943.

For respiration „ „ „ Q 5, First Paper, 1949

Also see ans. to Q. 6, First Paper, 1944.

Or,

Q. 3. *What is meant by root pressure? Explain clearly its relation with transpiration and ascent of sap.*

Ans. Root hairs absorb nutrient solution from the soil and send it to the cortical cells. These cells become turgid and the next layer of tissue gets supply of the solution from the turgid layers and the turgid layers become flaccid which again gets supply from the root-hairs. Thus a sort of pumping action goes on and ultimately this action reaches the xylem tissue through which the nutrient solution now passes and rises up the vessels reaching the leaves of the plant at last where food metabolism goes on. Thus a pressure is set up by which the nutrient solution rises to the leaves for being metabolised. This pressure is known as **root pressure**

The process of transpiration goes on, mainly from the surface of the leaves and thereby a process of evaporation goes on from the surface and more nutrient solution is sucked in. Thus a continuous pumping goes on from the root-hairs to the leaves whereby a stream of solution or sap ascends from the soil to the leaves. Thus the ascent of sap takes place.

For further information see *Ans.* to Q. 3, First Paper, 1953.

Q. 4. *How does an alga differ from a fungus? Illustrate your answer by comparing the types you studied.*

Ans. See *Ans.* to Q. 3, First Paper, 1945.

Or,

Q. 4 *What is alternation of generations? Illustrate your answer with reference to the life-history of Moss.*

Ans. See *Ans.* to Q 6, First Paper, 1946 or, Q. 6, First Paper, 1949.

Q. 5. *Write short notes on any five of the following .—*

(*a*) *Bordered pit,* (*b*) *Stomata,* (*c*) *Parasite,* (*d*) *Parthenogenesis,* (*e*) *Sporophyll,* (*f*) *Bulb,* (*g*) *Phylloclade,* (*h*) *Epigyny.*

Ans.

(*a*) **Bordered pit :**

During thickening of cell-walls by cellulose, in some cases it takes place uniformly and in others not uniformly but at places. During such development pitted appearance of the cells forming the vessels are seen. This may be either simple or bordered.

In bordered pits the secondary deposition of cellulose is unequal and protrude on both sides. Each protrusion may be seen circular and consists of two concentric circles as seen under the microscope. The space between the two circular thickening is the bordered pit and the central part is the torus.

(*b*) **Stomata :**

See *Ans* to Q. 7(*d*), First Paper, 1942.

(*c*) **Parasite :**

See *Ans.* to Q. 7(*g*), First Paper, 1940.

(*d*) **Parthenogenesis :**

See *Ans.* to Q 7(*a*), Second Paper, 1949.

(*e*) **Sporophyll :**

Some leaves, (as in fern) are set apart in a plant for bearing spores. These leaves are called sporophylls.

(*f*) **Bulb :**

It is a modification of an undergound stem. The stem forms a disc with nodes and internodes. Scale leaves develop from the nodes and overcrowd each other forming a globular body. There may be found auxillary buds growing from the axils of the scale leaves, *e g* , onion.

(*g*) **Phyloclade :**

In some zerophytic plants *i.e.*, plants growing in deserts or in a very dry climate, the leaves are greatly modified into spines or some such structurs and the stem becomes flattened or round appearing green and carrying on the functions of the leaves, Such modification of stems is known as phyloclade or cladode *e g.*, Phani Manasha.

(*h*) **Epigyny :**

This property is exhibited by some flowers where the thalamus is cup-shaped and the ovary is contained in it and fused with it The other three floral members *e g*, sepals, petals and stamens are placed above the gynœcium. Such a flowe is known as hypogynous flower, *e g.*, cucumber, gourd etc.

Second Paper

L Q. 1. *What is organic evolution, and what palaeontologica and embryological evidences are there in its support ?*

Ans Gradual changes in the universe. in course of tim is the law The earth has changed, the sun has changed, th moon has changed since their first appearance The earth ha been evolving into different aspects from time to time b being deposited with different strata. To-day's earth i quite different from what it had been some millions of year ago.

The animals living on the earth either in water or o land also are sharing the same changes in them in their form and functions during the course of the ages. A man of toda is not the man of the past. Various changes have taken plac in him though very gradually. Such changes are also foun in all animals and plants of today. Since the environment all biological units are changing from day to-day, they, i order to adapt themselves to those changed environments, ar also changing along with those surroundings. Such a change in biological units is called *Organic Evolution.*

Such organic evolution is supported by various evidences such as palaeontological, embryological and others.

Palaeontological :

It is also called geological evidence, The study of fossils supply us with strong evidences of the organic evolution.

Earth has been formed by one strata being deposited over the other from time to time. During these times the dead remains of the plants or animals have been kept within these strata and by studying these and also by calculating the age of strata some evidences as to the time of the biological existence is ascertained. The fossils in the lowest parts of the surface of the earth are the most ancient whereas the fossils of the modern organisms are found on the upper layers or strata of the earth.

Embryological :

Haeckel observed that "Ontogeny repeats Phylogeny". This means that the developmental history of an individual repeats the developmental history of its race and this is known as Re-capitulation Theory.

If we watch and observe the development of an adult complex organism, we shall see that when the development commences from a zygot, the organism passes through the stages of its primitive ancestral stages though for a short time and ultimately attains the complex form. Thus during the development of a bird or of a reptile or of a mammal each passes through a stage of fish in having developed the gills and branchial vessels, though they disappear later. This also is the case with a tadpole. A tadpole also resembles the fish during its development and hence we may call fish is the primitive ancestor of a tadpole. Thus the law of recapitulation is supported.

Q. 2. *Describe meotic cell division ?*

Ans. In meotic cell division during prophase chromosomes of the nucleus do not split up longitudinally as in mitosis. In this process the chromosomes of the nucleus lie paired either side by side or both coiled together and are called homologous. In this paired state they arrange themselves on the equitorial plane of the spindle (metaphase). Next from these paired chromosomes one half passes to one pole and another half to another pole. Thus each chromosome splits into two. *i.e.*, becomes half of what it was. Therefore it is a reduction and this is the main peculiarity in this process. Thus one phase is complete. Next the telophase begins. Here two daughter nuclei with half the chromosomes are formed. Thus it is the haploid state of the nucleus. Next the karyokinetic or mitotic division of these newly formed haploid state nuclei begins. In this way four new nuclei are formed each of which is in haploid state. Such reduction division *i e*, the formation of haploid state takes place in reproductive cells. *Meotic division is always followed by mitotic division.*

Q. 3. *Write what you know of the life history of the Monocystis ?*

Ans See *Ans.* to Q. 3, Second Paper, 1943.

Q. 4. *Describe the digestive organs of Hirudinasia ?*

Ans. See *Ans.* to Q. 3, Second Paper, 1950.

Q. 5. *Give the description of the compound eye o Palaemon.*

Ans See *Ans.* to Q 3, Second Paper, 1947 and also *Ans.* to Q. 7(*d*), Second Paper, 1945.

Q. 6. *Compare and contrast the hearts of Lates Calcarife and Bufo melanostictus ?*

Ans.

Heart of Lates Calcarifer :

The heart of Lates Calcarifer *i.e*, of Bhekti is situated i the anterior part of the body cavity and lies ventral t the oesophagus. It is enclosed within a very thin an transparent membrane called pericardium. It consists of :—

1. One Sinus Venosus.
2. One auricle and
3. One Ventricle.

The situation of these three chambers ;

The whole heart lies ventral to the œsophagus. The sinus venosus lies dorsally. Ventral to the sinus venosus is the auricle and ventral to the auricle lies the ventricle.

1. The sinus venosus receives deoxygenated *i.e.*, impure blood that has drained from the whole body by means of **two** cuvierian ducts.

2. The blood from the sinus venosus passes to the **single** auricle through a sino-auricular opening.

3. From the auricle again the blood passes to the single ventricle through the auriculoventricular opening. Next the blood which is impure passes from the ventricle to the median vessel arising from the apex of the ventricle and is called the ventral aorta. It is swollen at its base where it arises from the ventricle and is called the **bulbous aorta.**

Each opening in the above, communicating heart chambers, is guarded by valves. The valves are so placed that blood can pass in one direction only and not backwards *i.e.*, the blood cannot regurgitate.

Heart of Bufo melanostictus :

The heart of Bufo melanostictus *i.e*, of toad lies in the anterior part of the body cavity. It consists of **five** chambers. The whole of the heart is covered by a very thin transparent membrane called pericardium. The heart consists of :—1. One Sinus Venosus. 2. Two auricles—right and left. 3. One ventricle and 4. One conus arteriosus.

1. The Sinus Venosus is somewhat triangular in shape and is fed by deoxygenated blood through its three corners by means of the venae cavae, one posterior and two anterior. This sinus venosus opens into the right auricle by means of the sinoauricular aperture.

2. The two auricles are partitioned by a strong wall called interauricular septum.

3. The Right auricle opens into the Ventricle.

4. The left auricle receives oxygenated blood from the lungs by means of the common pulmonary vein and open into the ventricle.

5. The two auricles open into the ventricle by a common opening called auriculo-ventricular aperture.

Thus the ventricle receives both oxygenated and deoxygenated bloods.

6. Behind the auricles is the thick-walled chamber called ventricle. The posterior end of the ventricle is the apex of the heart.

7. From the base of the ventricle arises the stout conus arteriosus. It lies ventrally to the ventricles. It passes obliquely to the left and is continued with the truncus arteriosus in front.

8. Here also each opening is guarded by valves allowing the flow of blood in one direction only.

The main differences in the two hearts are the following :—

	Bhekti	**Toad**
1.	Developmentally, of low grade.	Developmentally of high grade.
2.	Simpler.	More complex.
3.	Consists of three chambers.	Consists of five chambers.
4.	Sinus venosus receives blood from the body by **two** cuvierian ducts.	Sinus venosus receives blood from the body by **three** venae cavae.
	Both the ducts open into the sinus by a single opening.	The three venae cavae open into the sinus by three different openings.
	The ventricular structure is simpler.	Ventricular structure is more complex.
	The ventricle contains all impure blood.	The ventricle contains both pure and impure bloods.

Q. 7. *Give a full description of the pectoral guinea pig and toad.*

Ans.

Pectoral girdle of guinea pig :

See *Ans.* to Q. 5, Second Paper, 1948.

Pectoral girdle of toad :

See *Ans.* to Q. 5, Second Paper, 1951.

Q. 8. *Write notes on · Fossa ovalis, Neurone, Columella-auris, olecranon process, Zygapophysis*

Ans.

Fossa ovalis :

In embryonic state, in guinea pig there is an inter-comunicating foramen on the wall of the inter-auricular septum and is called the *foramen ovale.* Before birth however this foramen is closed and a small depression persists This depression on the wall of the septum is known as **fossa ovalis.**

Neurone :

It is the nerve cell with a number of cell processes. It is the unit of a nerve, tissue. Its nucleus is conspicuous and oval. A number of dark staining granules are seen in the cytoplasm. These are called the Nissel's granules The cell processes of the neurone are :—

1. The cell body. 2. Some short processes called **dendrites** or **dendrons** 3. Some long processes, called **axons.**

Dendrons or dendrites pass impulses to the cell whereas axons pass the impulses from the cell.

Columella auris :

Toads have no external ear. They have the middle ear. This middle ear is represented by a bony rod called columela which is attached to the cochlea, and forms the internal ear. Sound is conducted by this columella to the cochlea and next to the auditory nerve.

non process :

The elbow joint in the guinea pig is formed by ulna and radius of the fore arm and the lower end of the humerus. This joint is a hinge joint. The *proximal end of the ulna* that articulates with the distal end of the humerus at its trochlea, is known as the oleoranon process.

Zygapophysis :

From the lateral aspects on both sides of the neural arch of each vertebra, there are two transverse processes, one on each side. In front of this arch and also behind this arch, there are lateral projections one on each side. These are the articular processes and each is called **Zygapophysis.** Anterior to this is the pre-zygapophysis and posterior to this is the post-zygapophysis.